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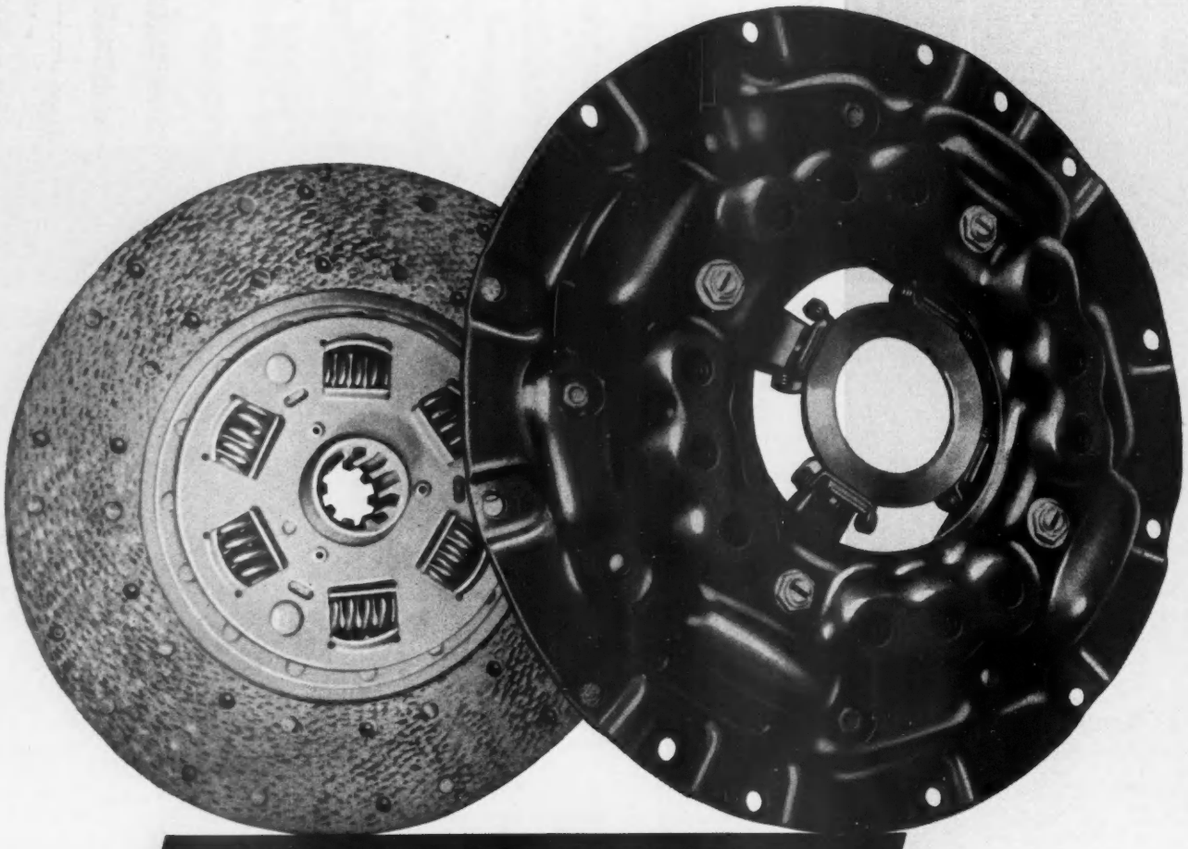

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Borg & Beck clutches are made in a wide range of sizes, from those for light cars to large twin-plate clutches for very heavy equipment.

They incorporate the experience gained in the design and manufacture of twelve million British made clutches and embody many distinctive features which ensure consistent and dependable performance.

The top illustration shows the 15-inch single dry-plate clutch, one of a range of 'strap-drive' clutches in which the pressure plate moves without metal-to-metal sliding contact. The smaller unit is a 6¼-inch clutch.

Catalogue of Borg & Beck clutches and Rockford over-centre clutches and power take-offs on application.

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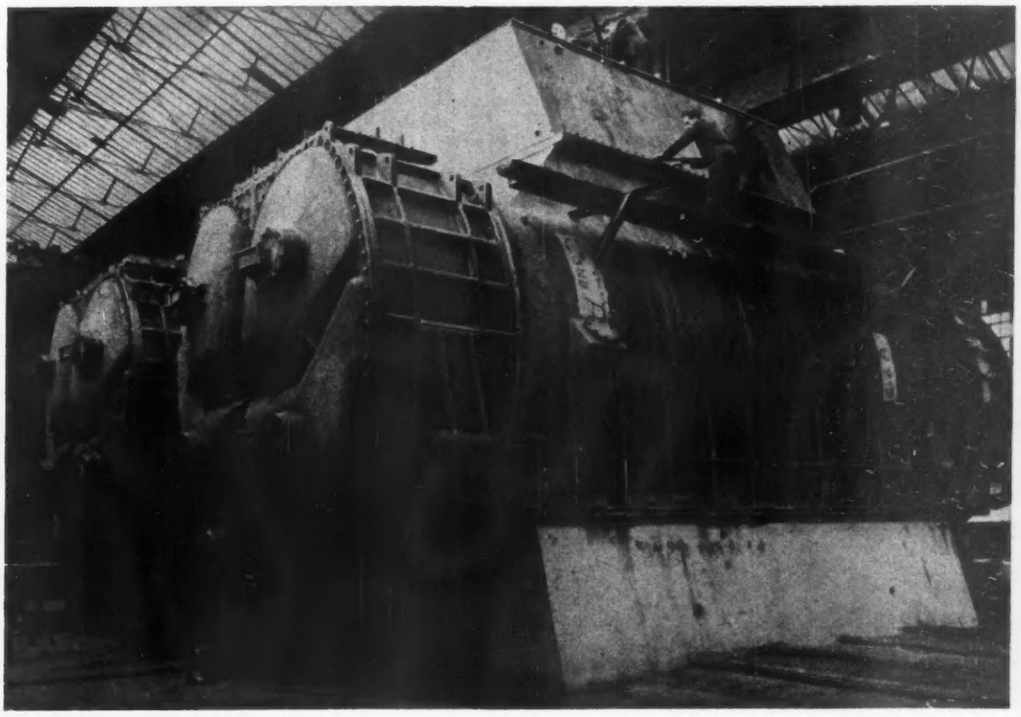

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REGENERATIVE CONDENSERS *for* SKELTON GRANGE "B"

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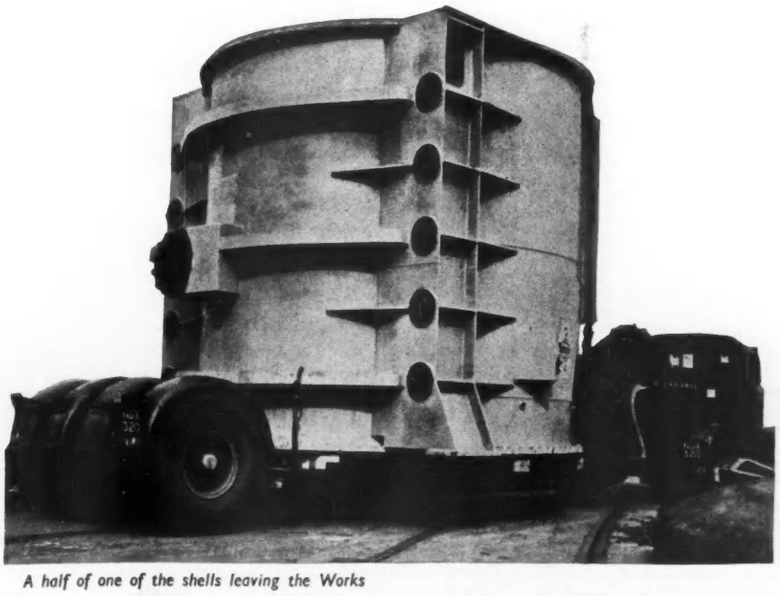

A half of one of the shells leaving the Works

This is the first of four Weir Regenerative Condensers for the 120 MW Turbo-alternators at the C.E.G.B. Skelton Grange "B" Power Station. Each shell is 25 ft. 9 in. long and 14 ft. in diameter, and the total cooling area is 85,000 sq. ft. (over 60 miles of tubing!)

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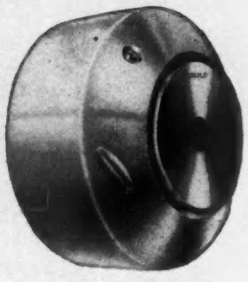

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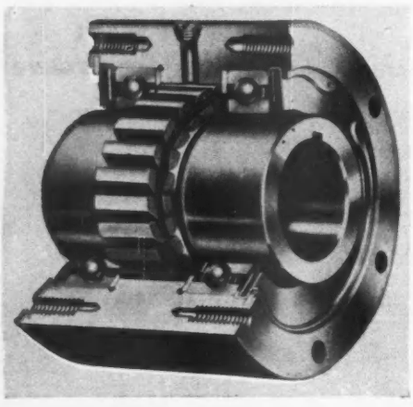

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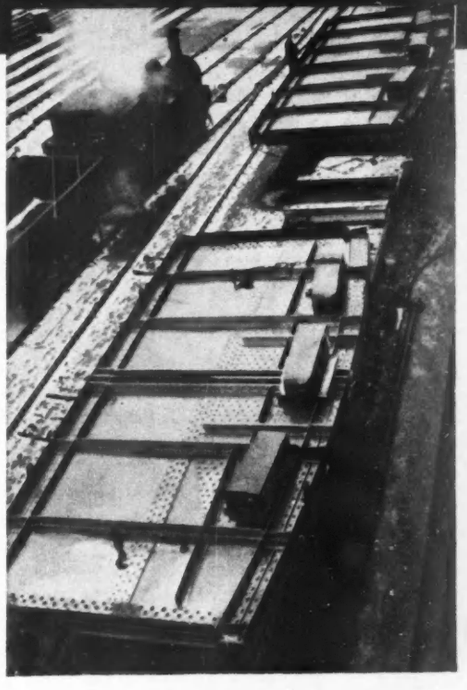

Shipping bridge members for erection overseas

In addition to building bridges in any part of the world, Dorman Long export fabricated bridge members for erection locally, often by semi-skilled labour.

The illustrations show bridge girders on the way to Saigon, for bridges at Dong Nai and Saigon.

Other fabricated steelwork recently sent overseas includes heavy steelwork for the melting shop of the Durgapur steelworks, and fabricated members for the Auckland Harbour Bridge and the Rohri Channel Bridge, Sukkur, West Pakistan.

The Dorman Long constructional engineering shops are the largest in the United Kingdom and are capable of dealing with the heaviest classes of work as well as lighter structures.

In the bridge yard, trial erection of structures takes place before the fabricated members are despatched for erection on site, whether at home or overseas.

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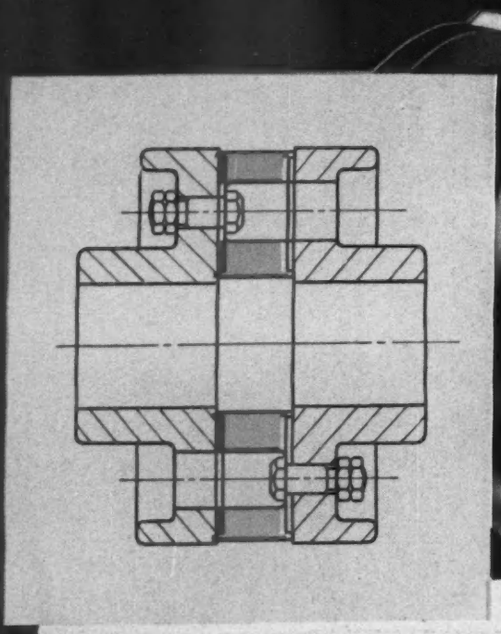
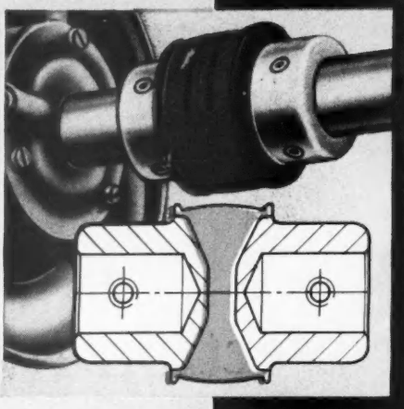


MISALIGNMENT TORSIONAL VIBRATION TORQUE FLUCTUATION

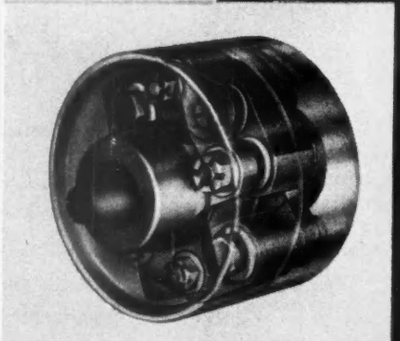


According to application Metalastik flexible couplings allow for angular or parallel misalignment or the two combined. Axial travel is accommodated by some couplings, or when required, axial thrust can be transmitted with insignificant deflection. Still other couplings accentuate torsional vibration damping or the capacity to smooth out fluctuating torques. Over twelve different types of coupling enable us to provide the most suitable unit for an extremely wide range of applications.

Disc couplings, top of page, allow for angular and parallel misalignment, end-float, and absorb large irregularities in power transmission. In sizes to transmit 0·8 to 96 h.p. per 100 r.p.m. they can be fitted without interfering with machinery setting.

Barrel Couplings (centre) combine great torsional flexibility with the capacity to accommodate parallel and angular misalignment. In sizes for drives of 0·005 to 0·54 h.p. per 100 r.p.m. they are ideal for connecting motors to light machines.

The ghost view shows the Metalastik Trailing Link coupling which permits exceptional parallel misalignment and is available in sizes to transmit 1 to 20 h.p. per 100 r.p.m.



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New Books and Trade Publications

Cover Picture

Assembling the pumping element of a double bank fuel pump for an aircraft gas-turbine. The element incorporates the drive and mounting housing and also the governor which limits the maximum speed of the turbine by restricting the fuel flow to the pump. (*Nurnberg photograph for* ENGINEERING)

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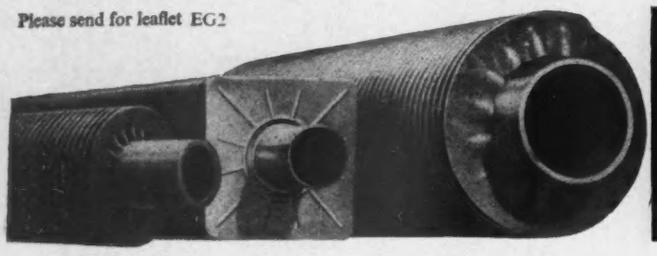

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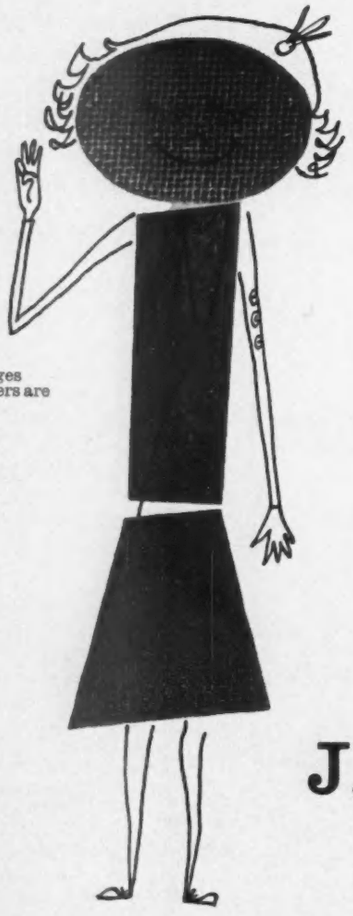

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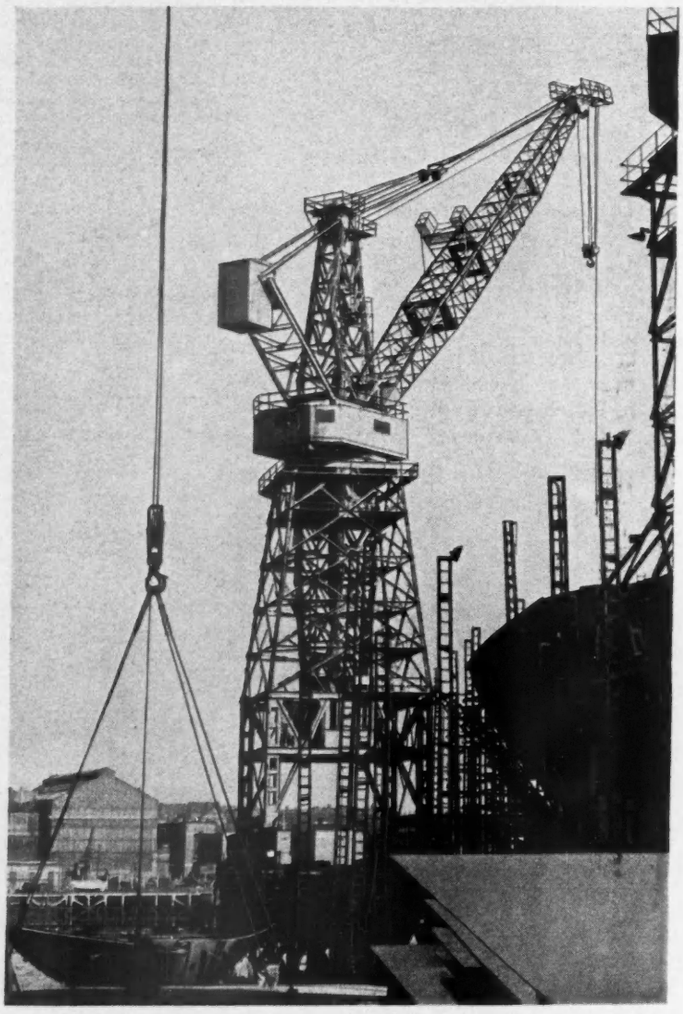

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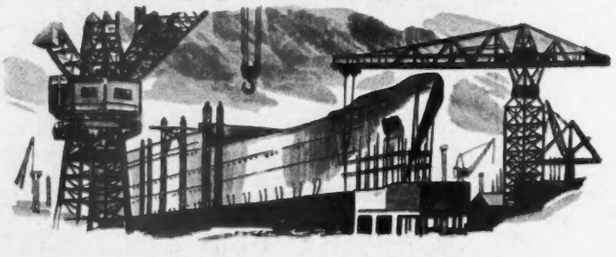

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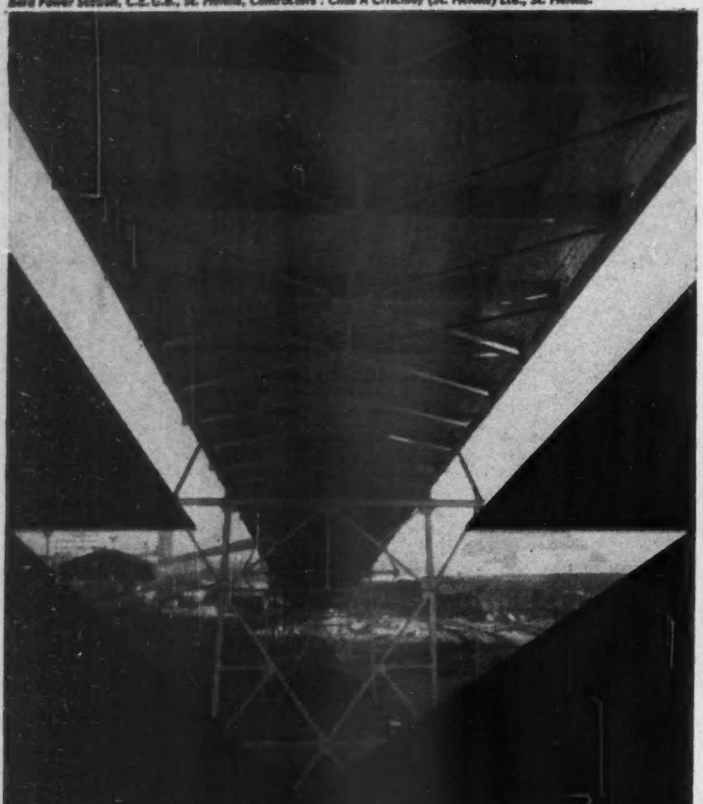

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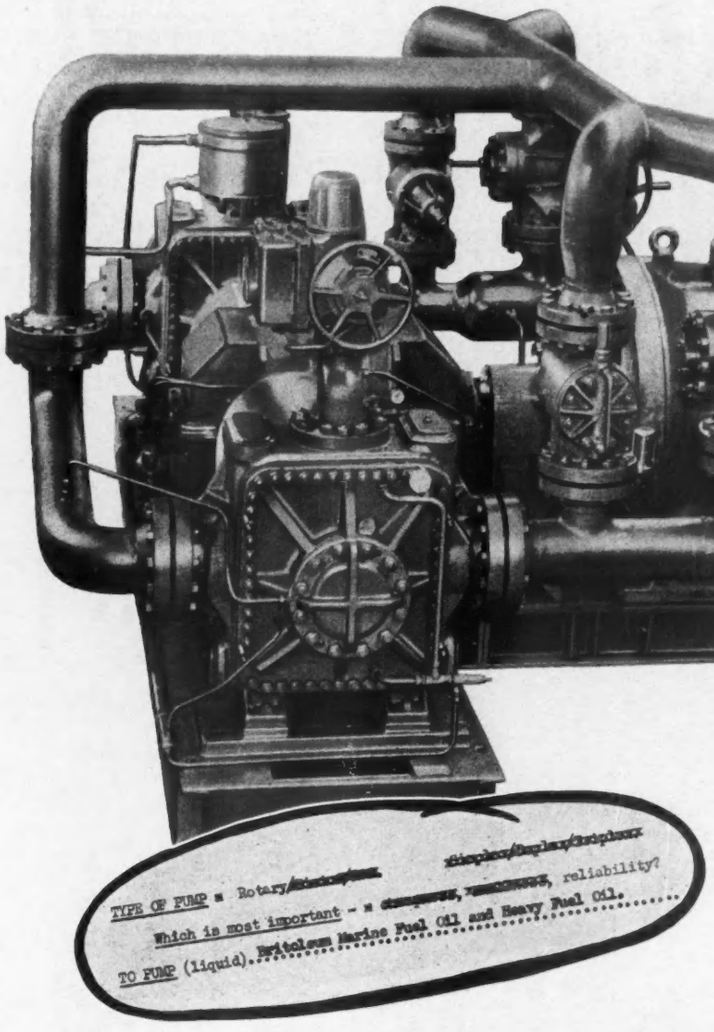
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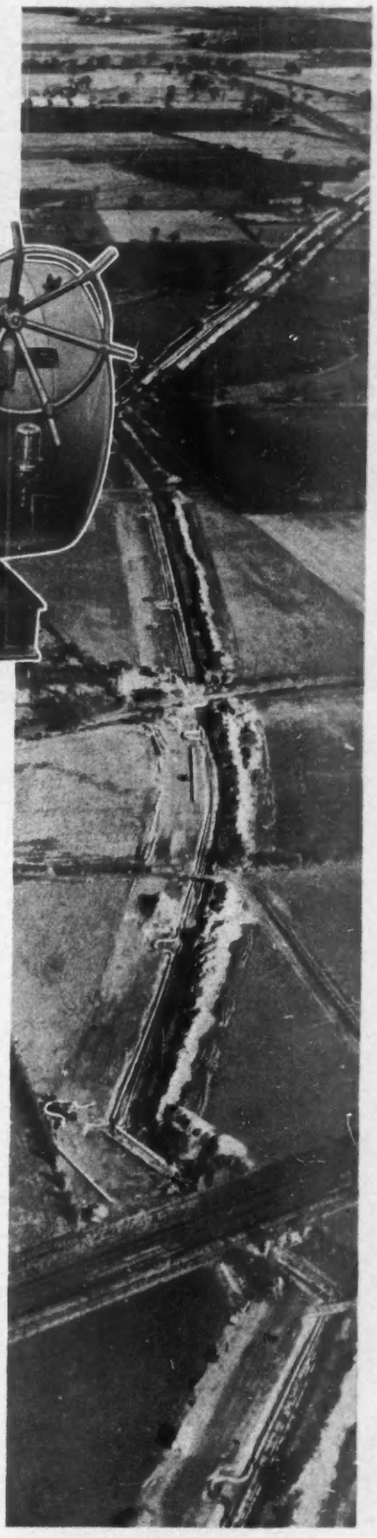

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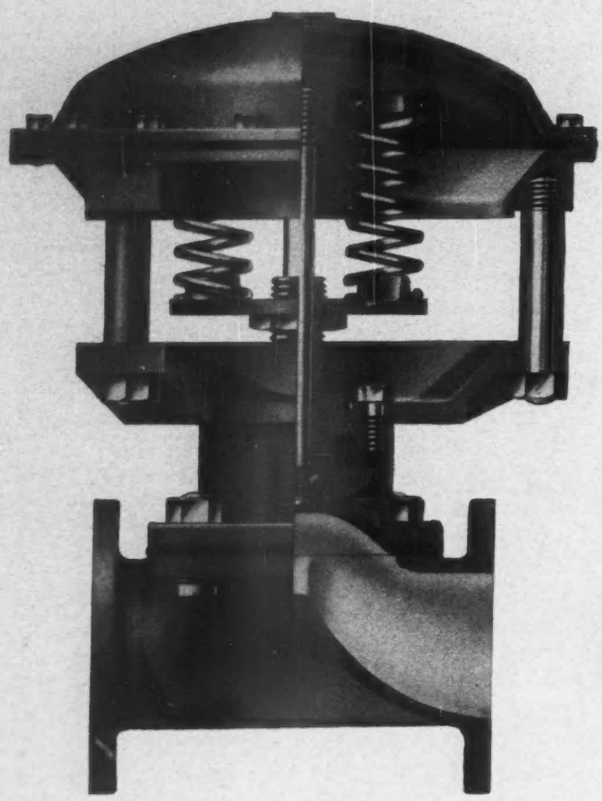

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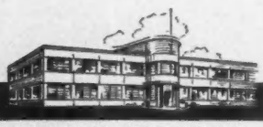

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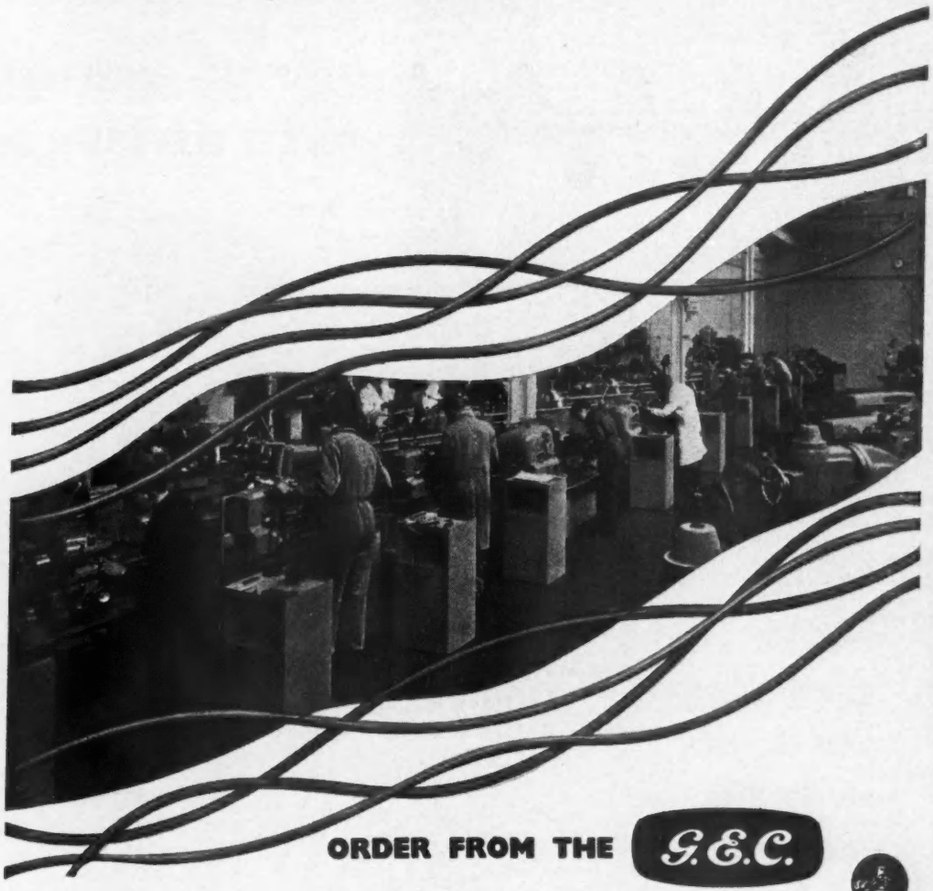

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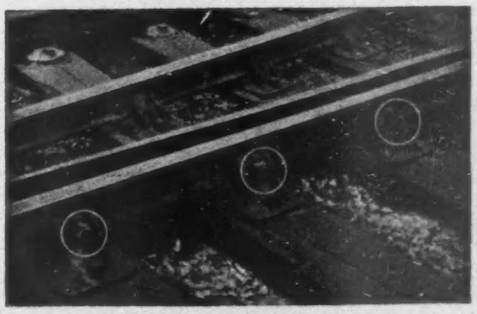

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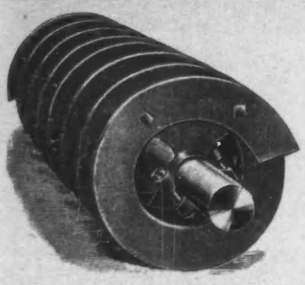

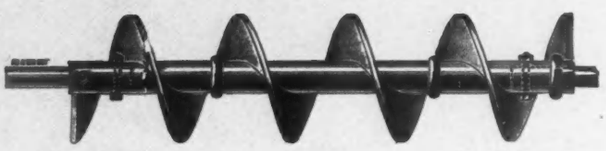

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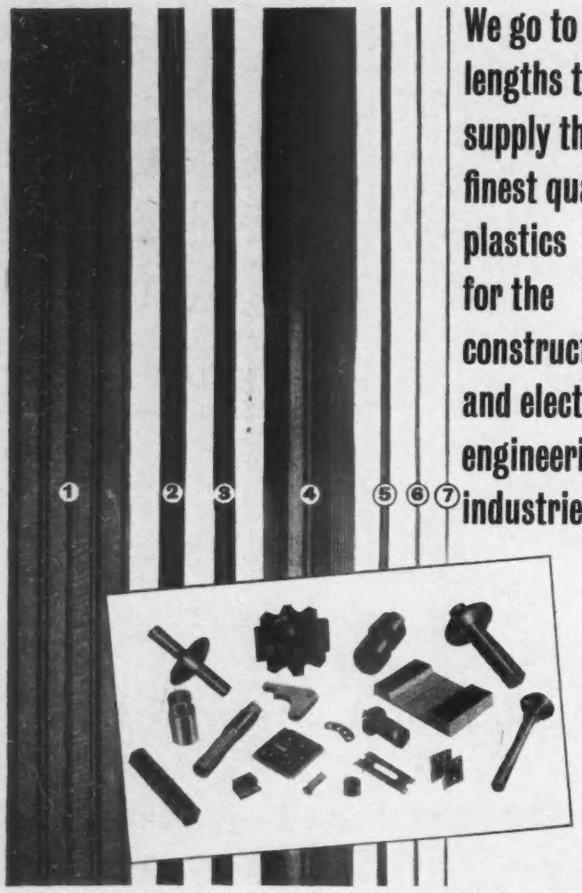

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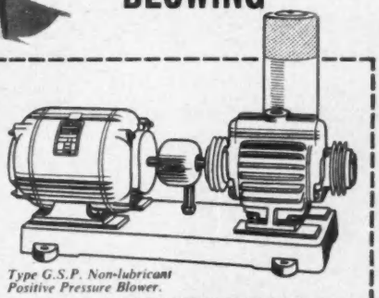

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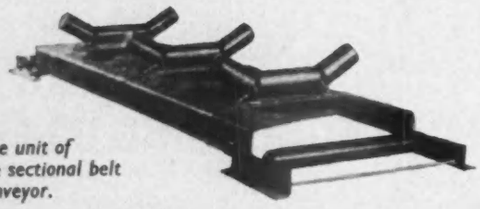

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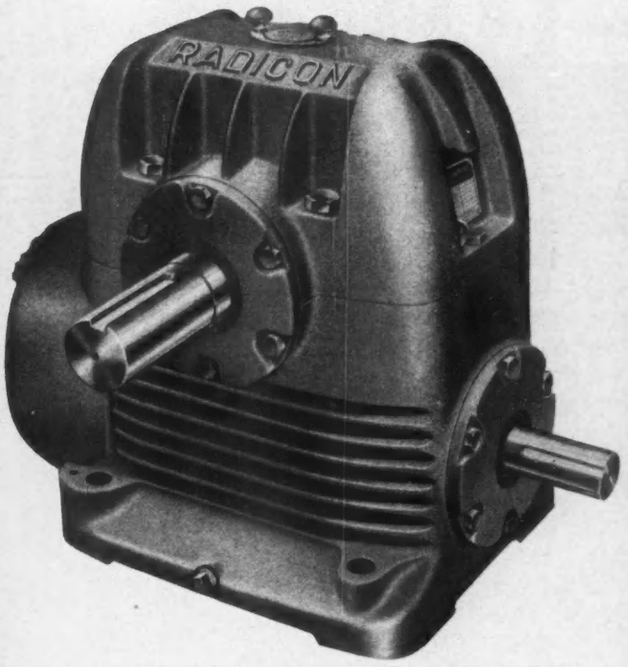

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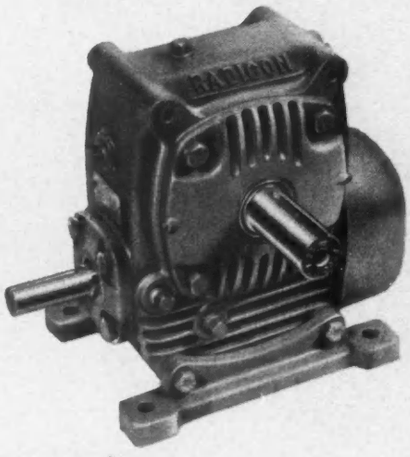

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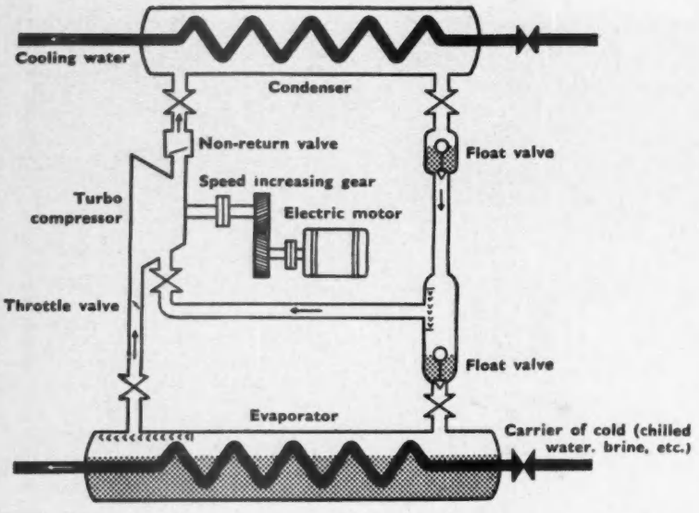

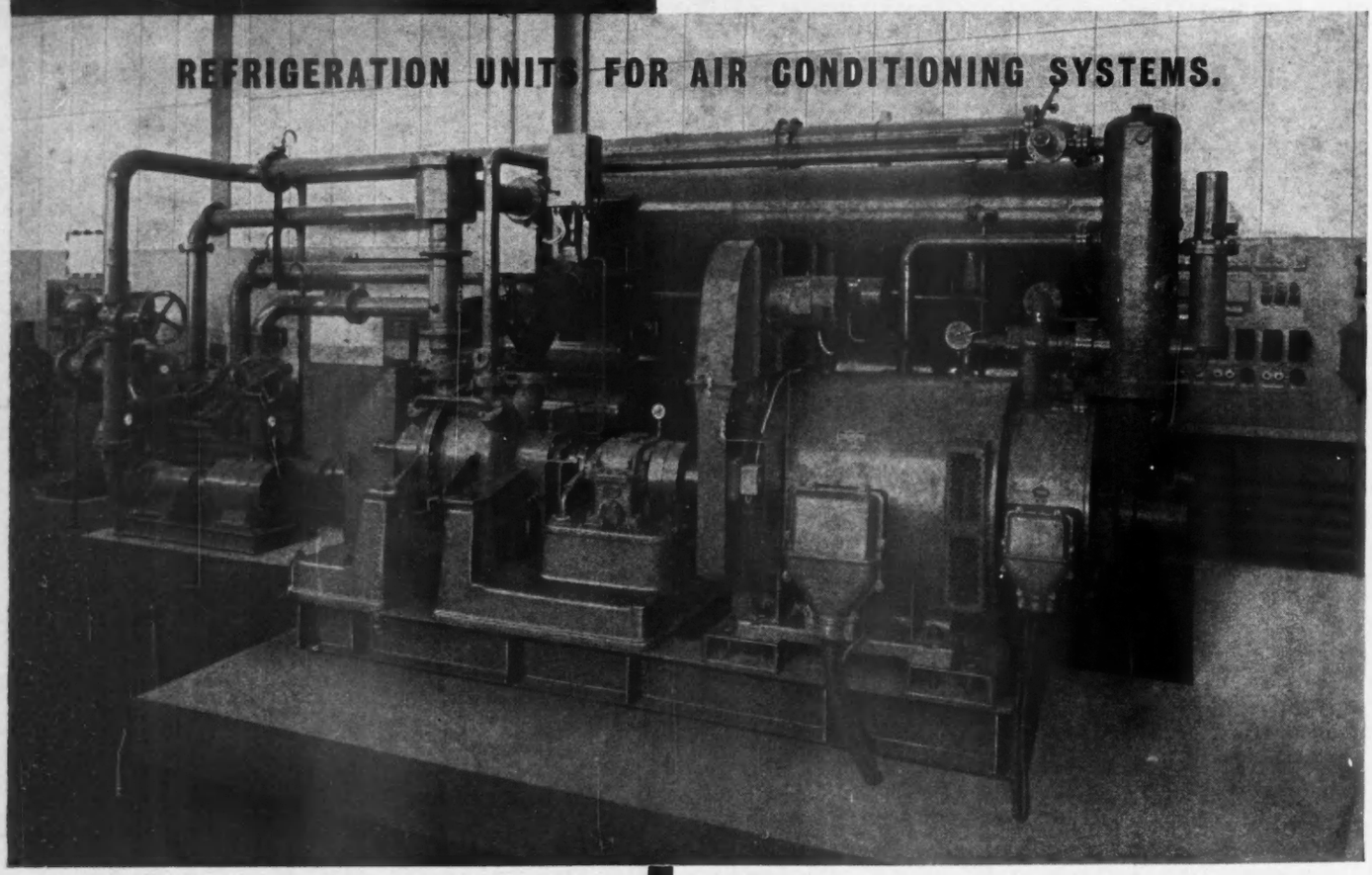

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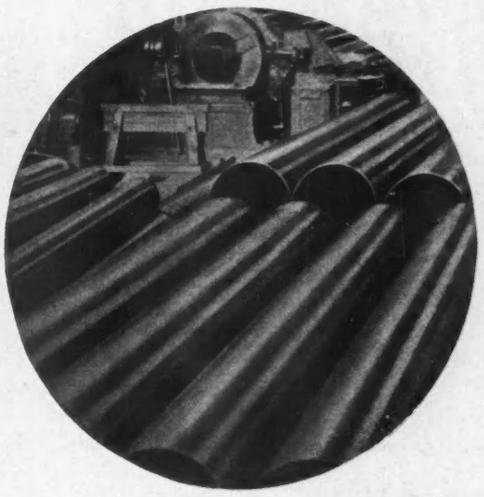

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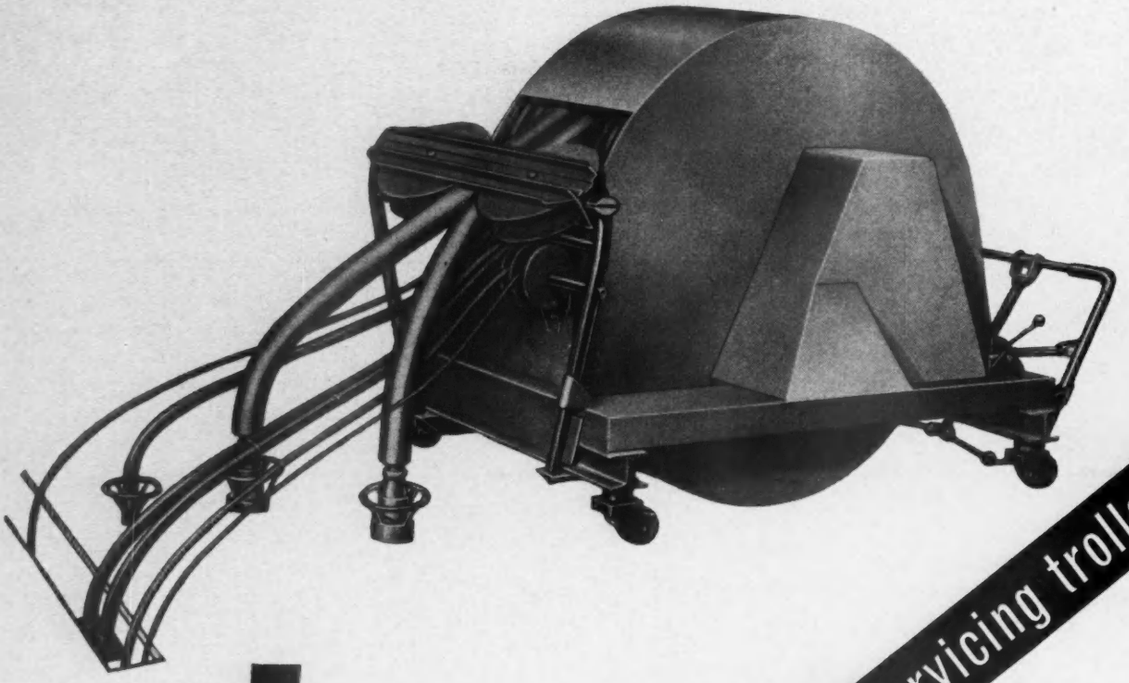

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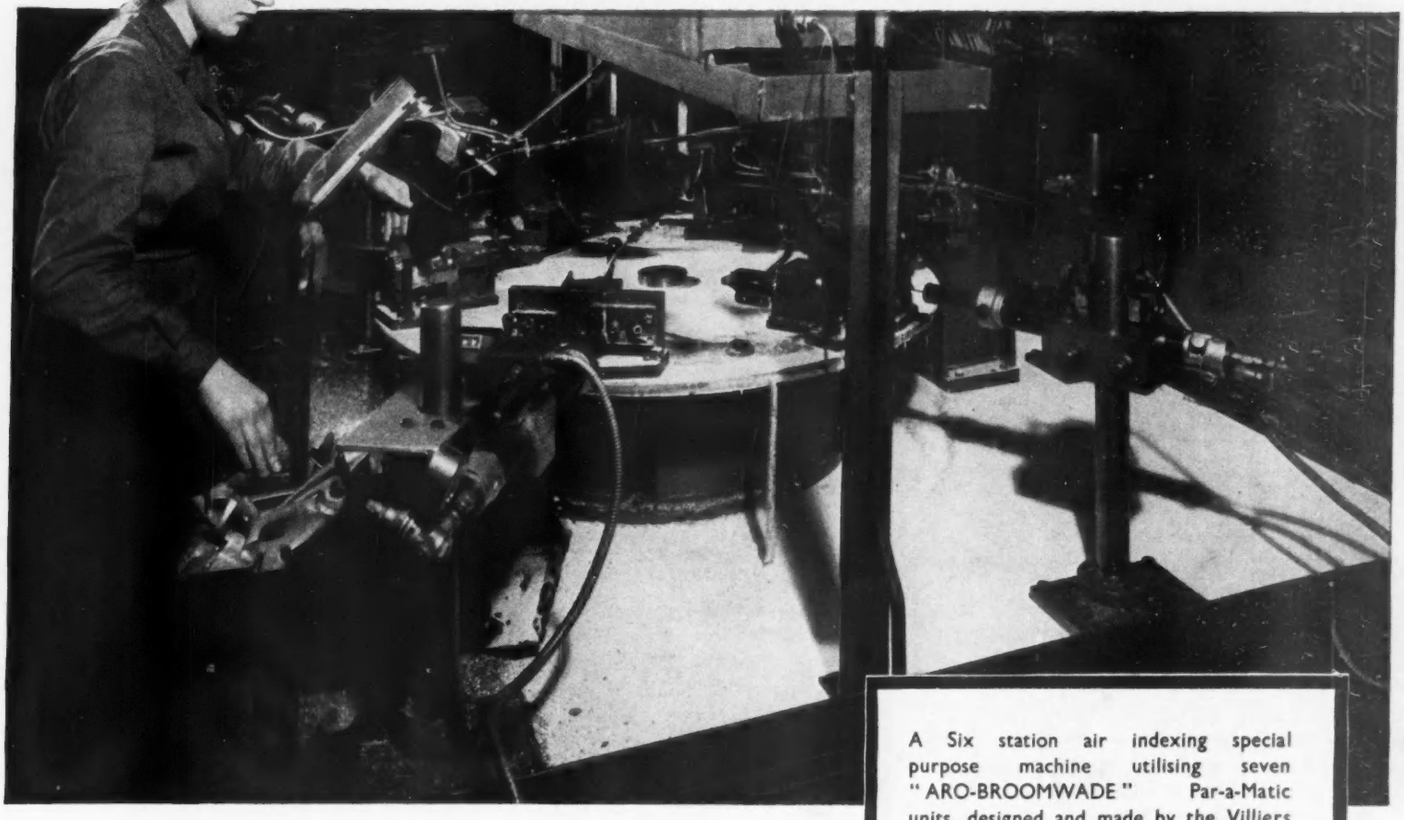

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5th Station ..	Tap 1 hole 6 BA.
6th Station ..	Unload fixture and load fresh component.

Special note should be made of the two spindle drilling head attached to the PAR-A-MATIC for drilling the two close spaced holes at Station No. 3. Photograph by courtesy of Messrs. Fry's Diecastings Ltd.

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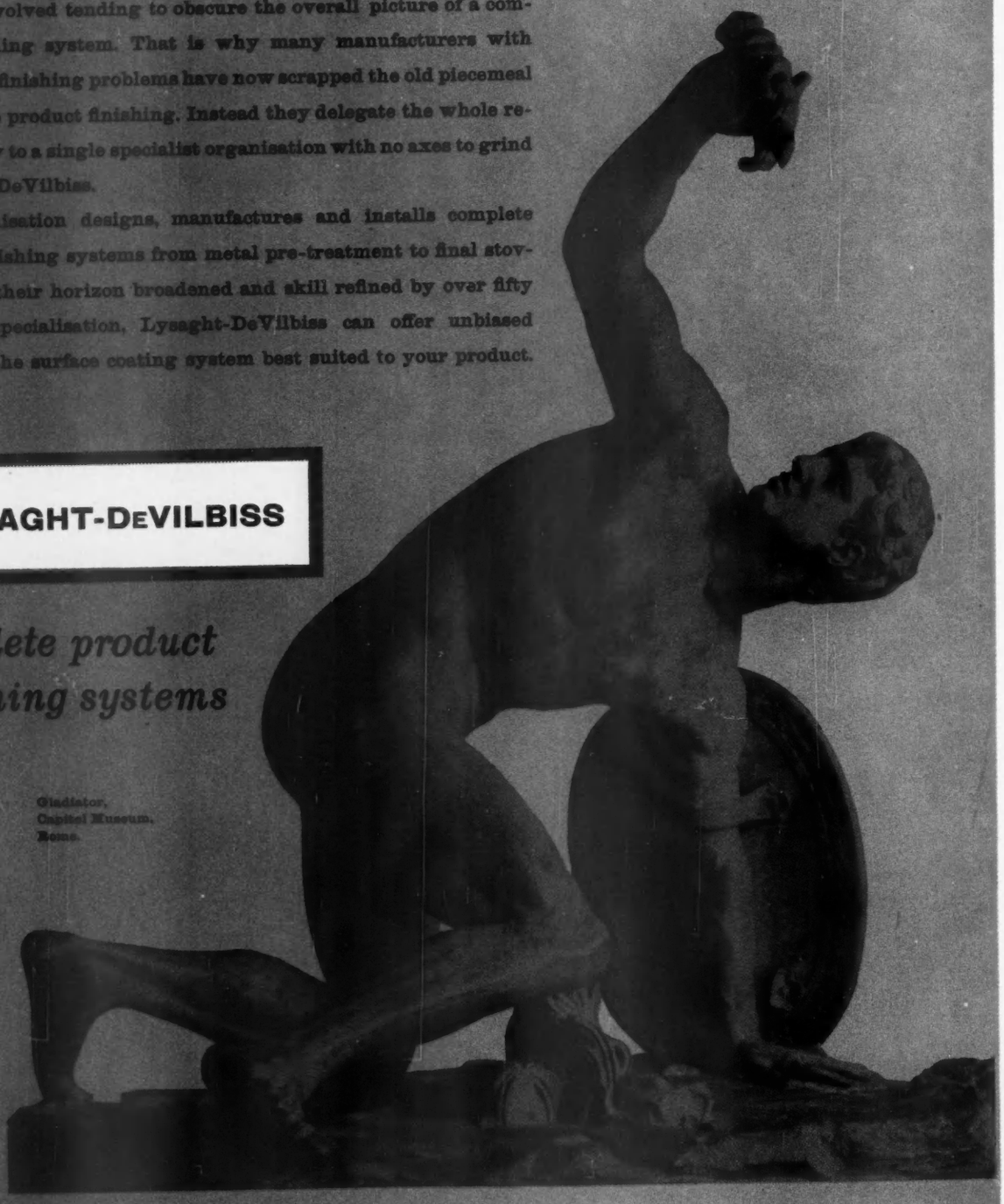

Gladiator, Capitol Museum, Rome.

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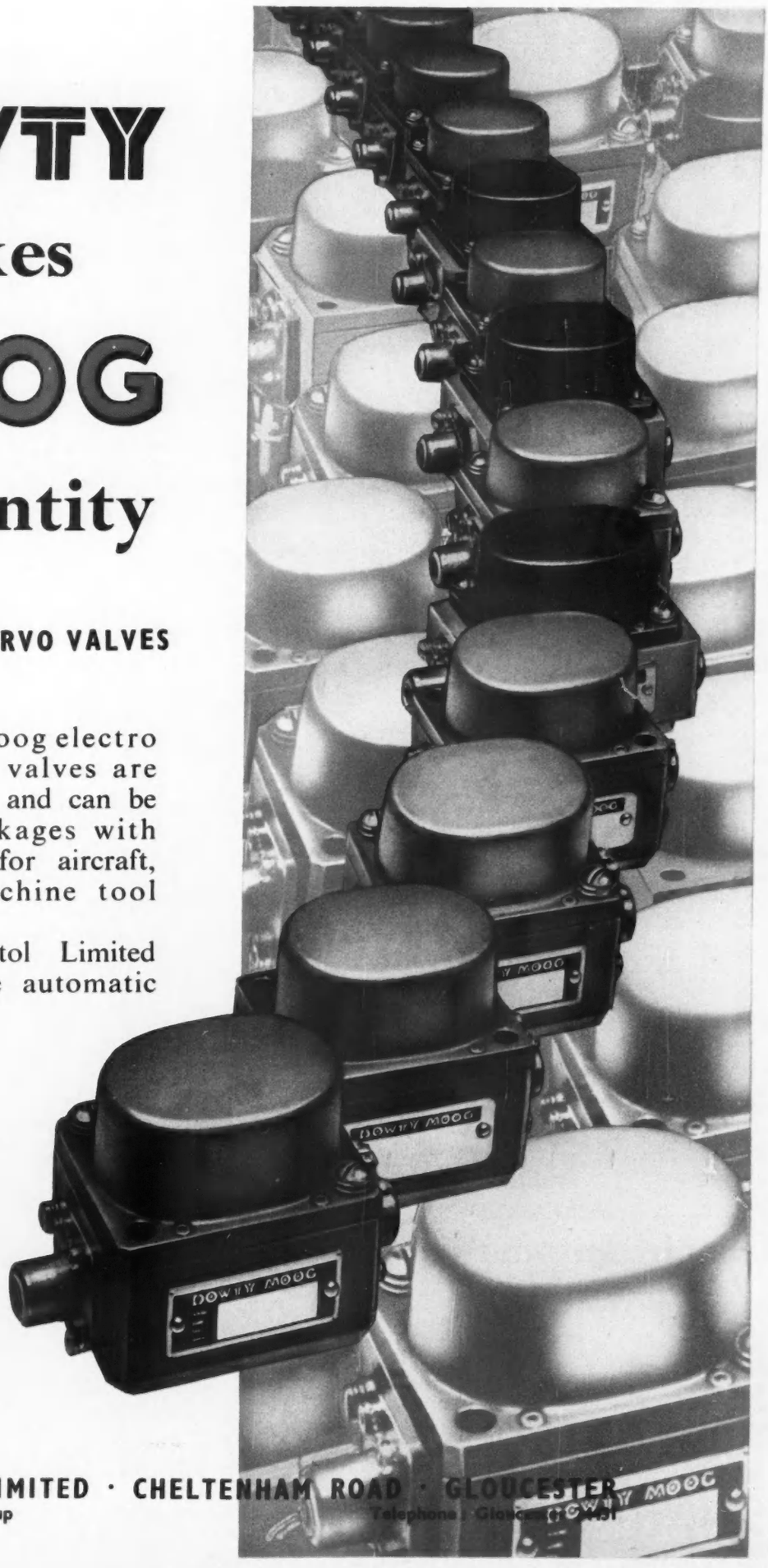

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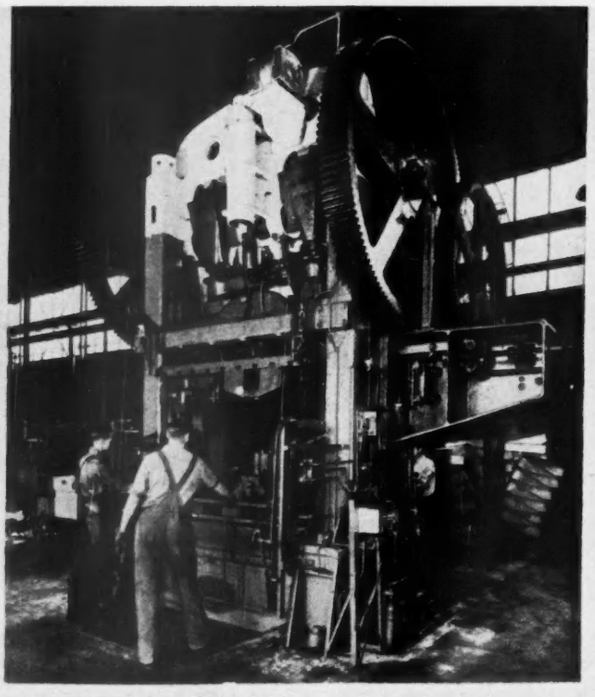

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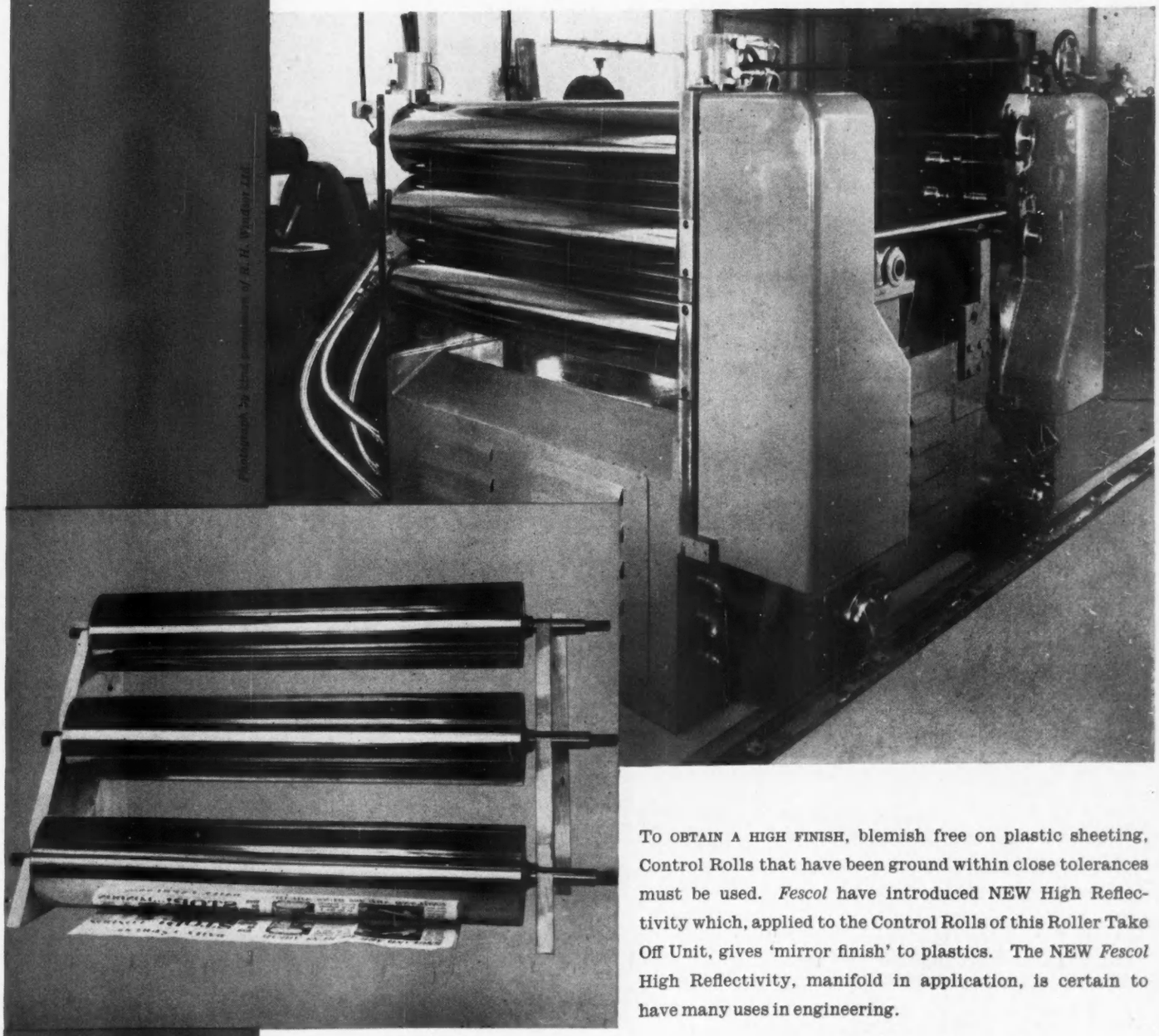

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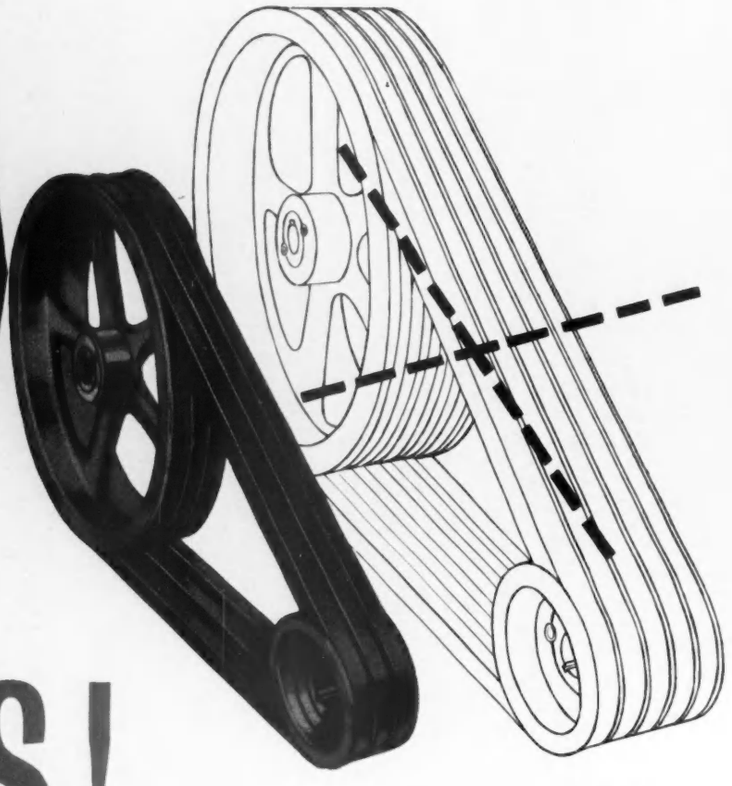

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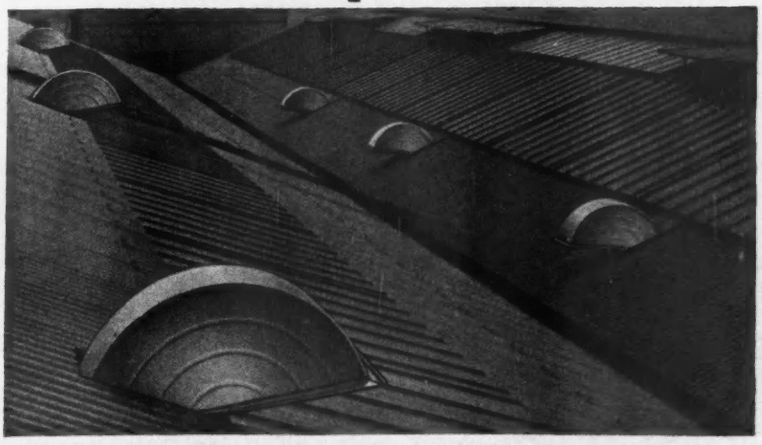

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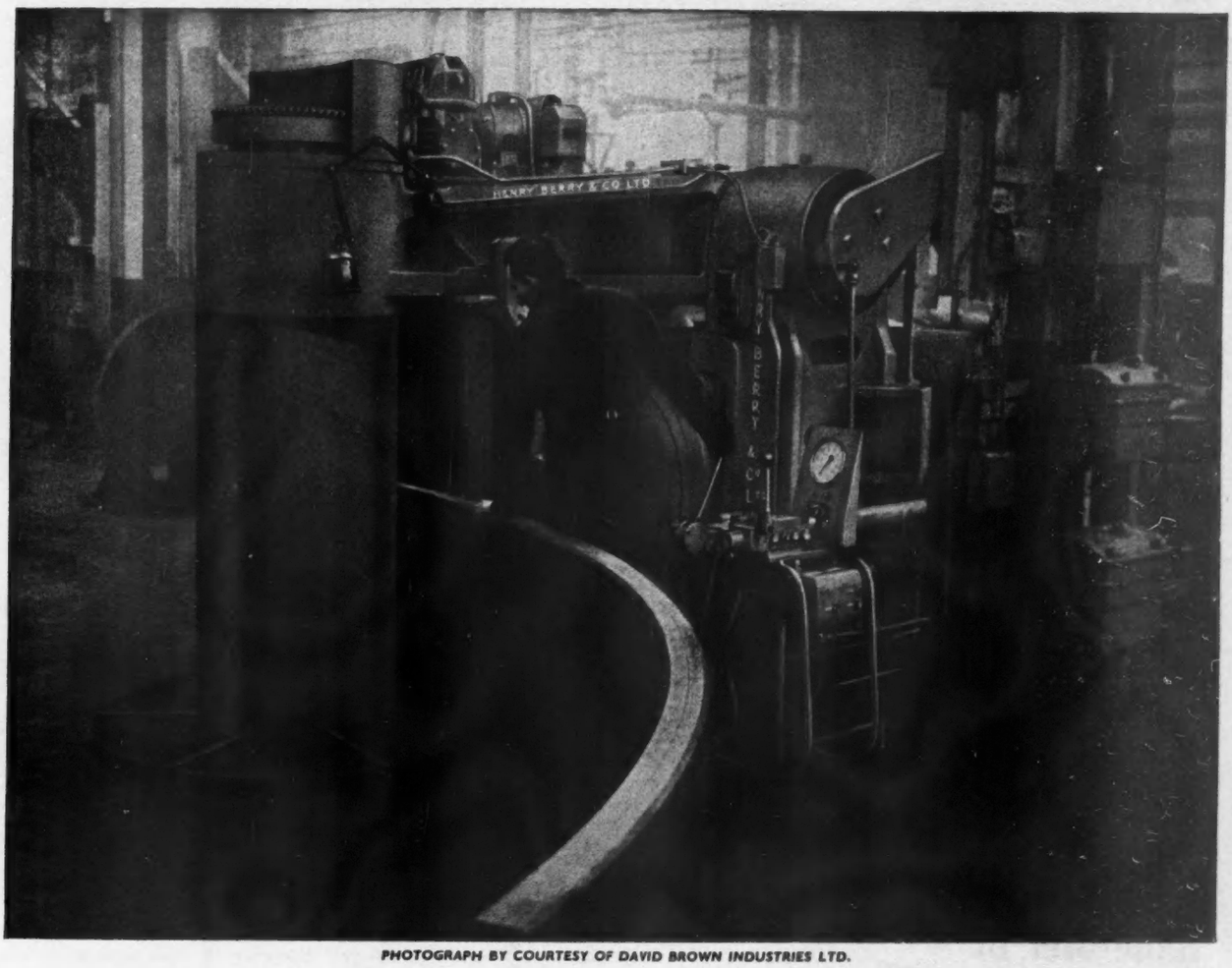

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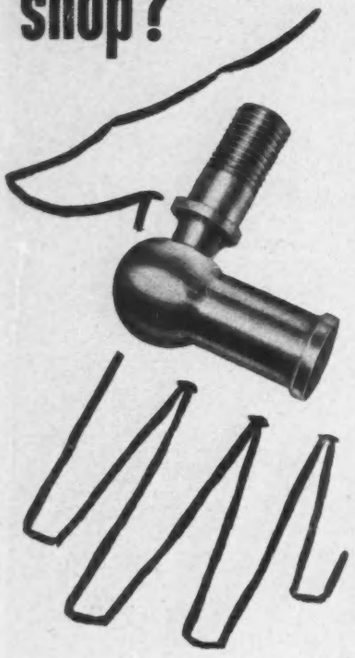

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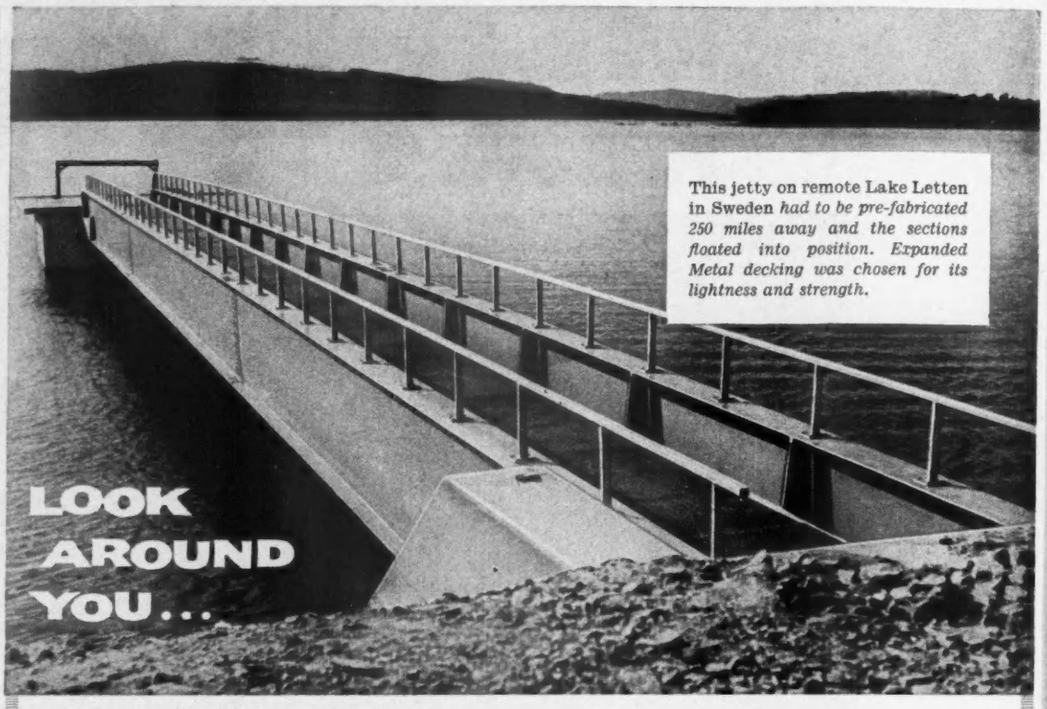

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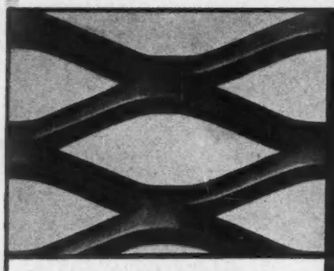

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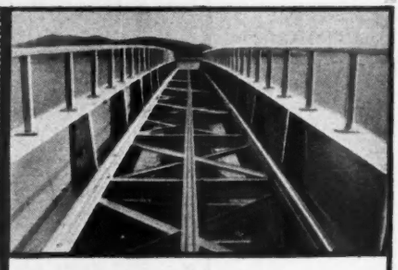

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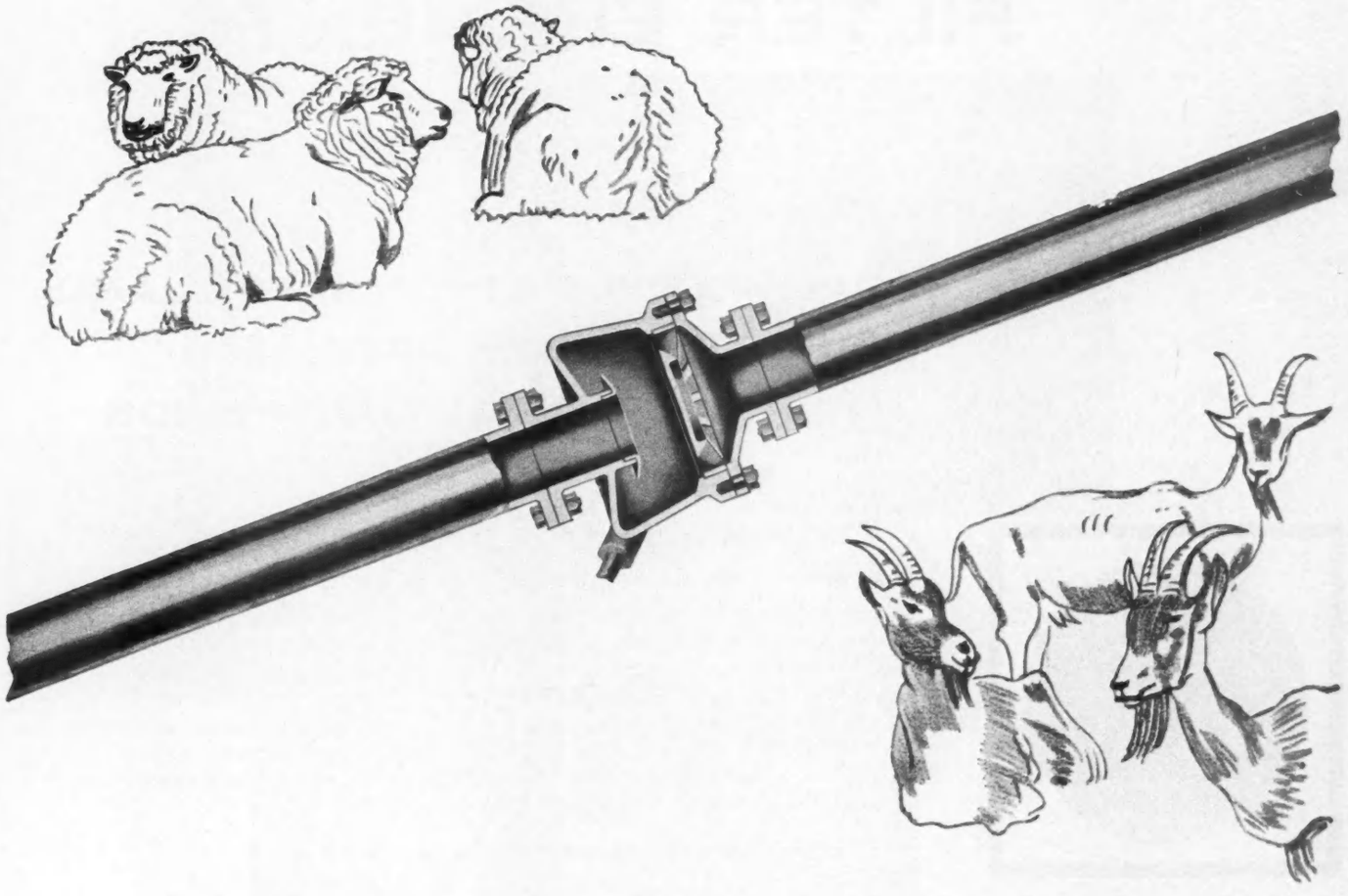

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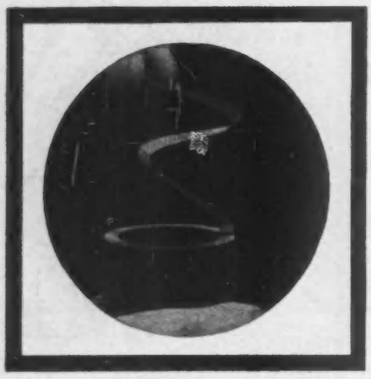

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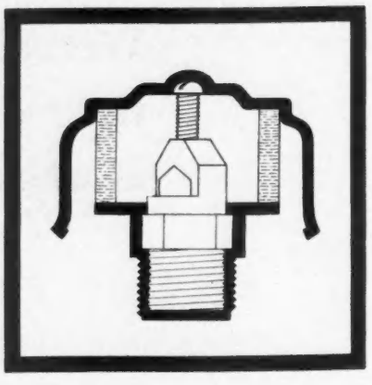

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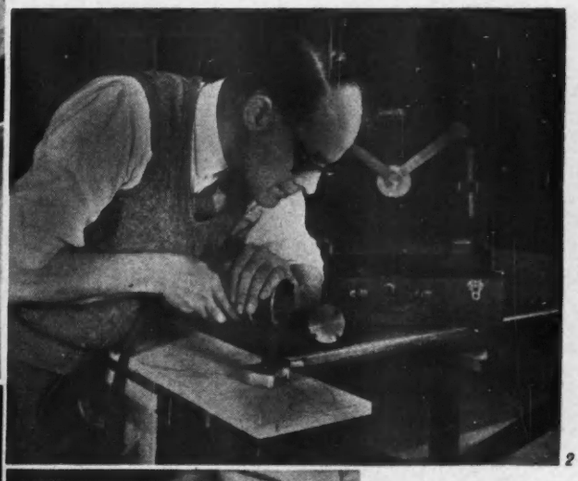

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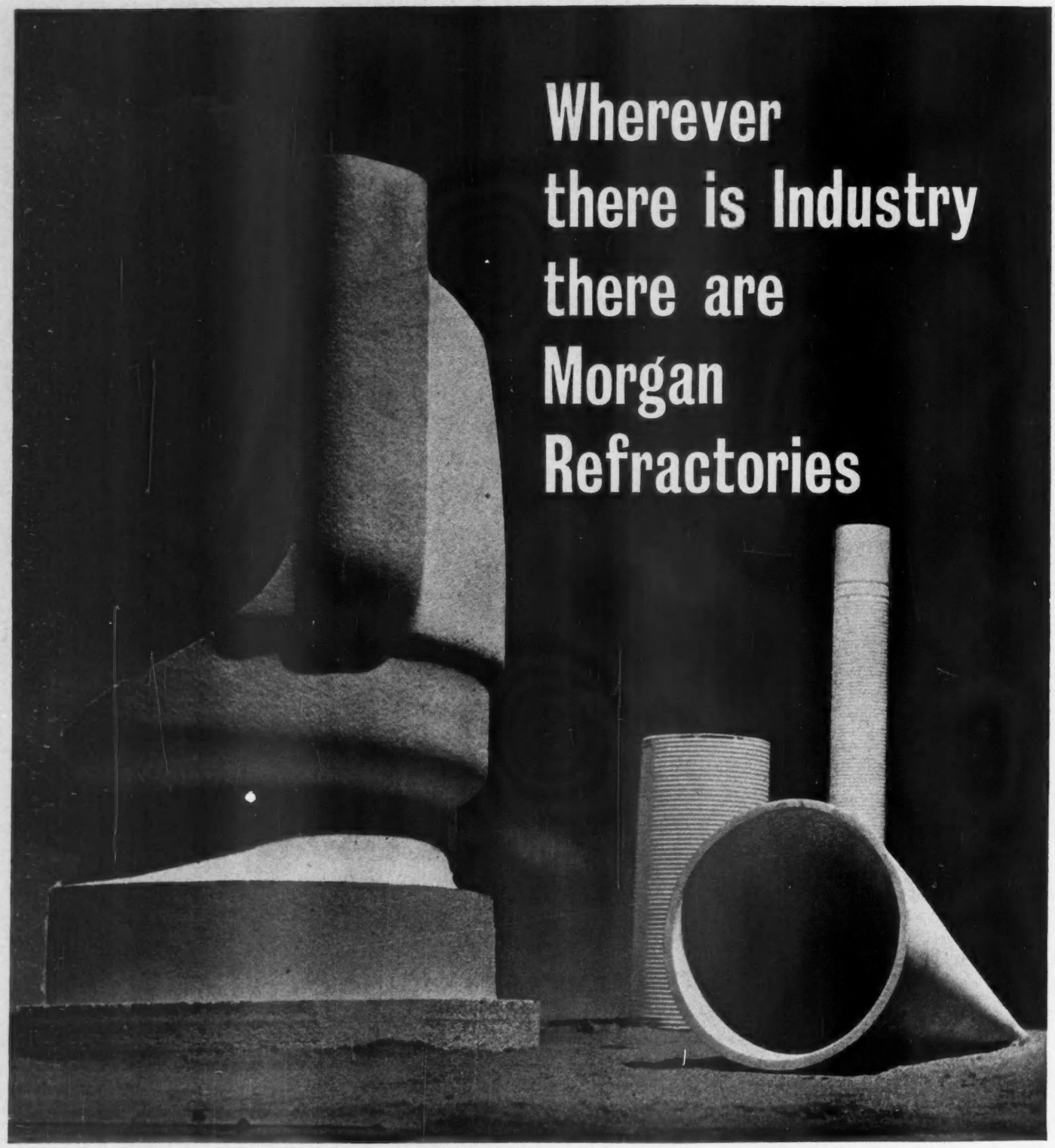

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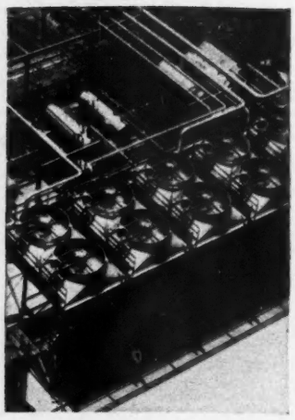

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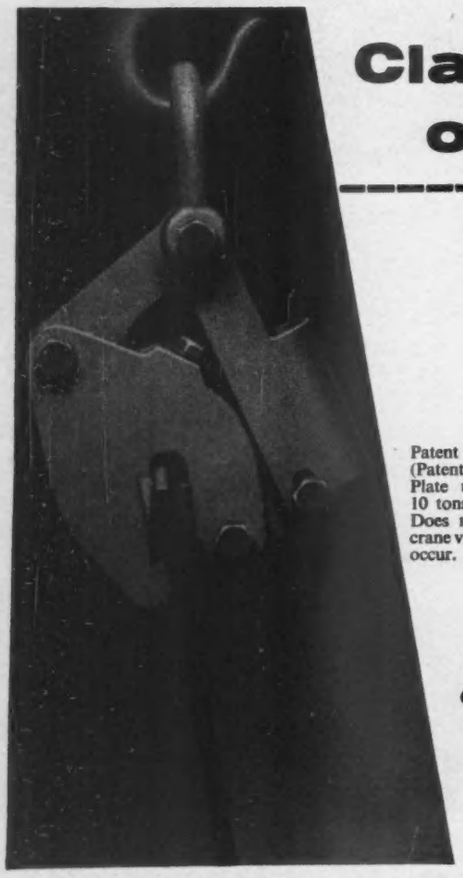

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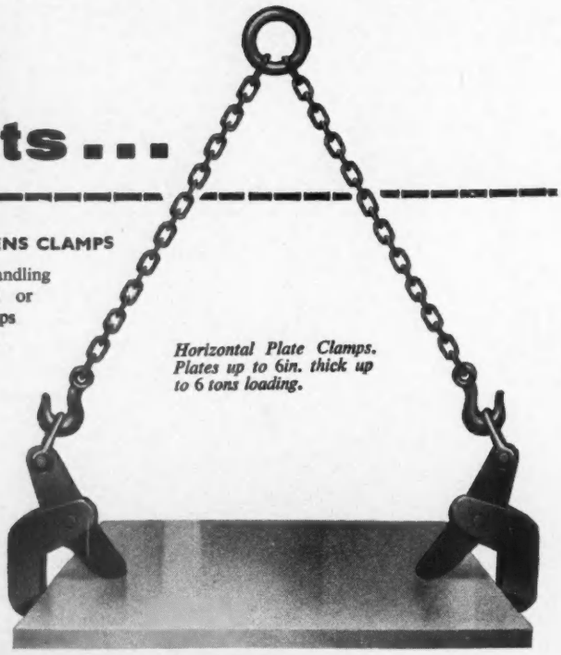

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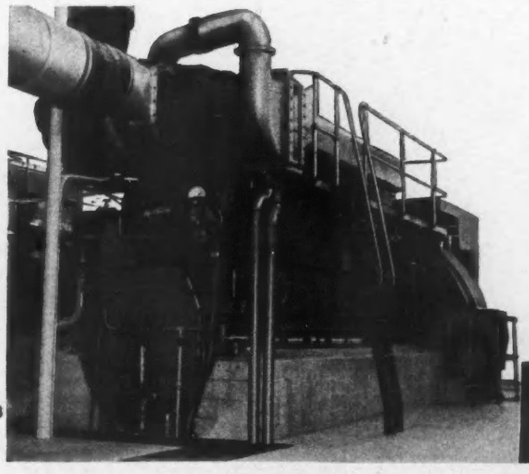

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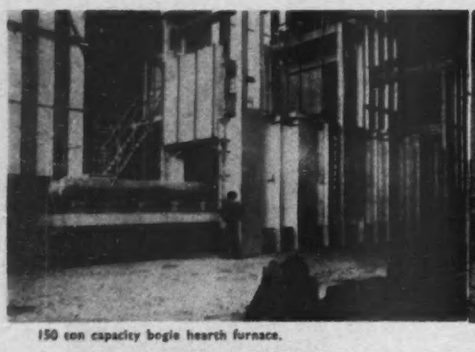

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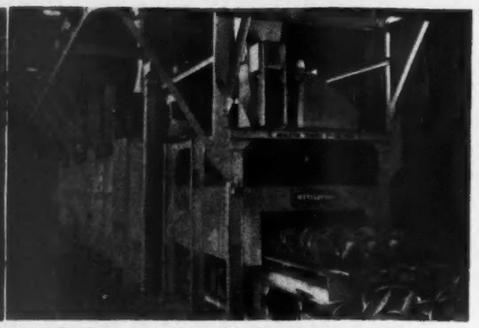

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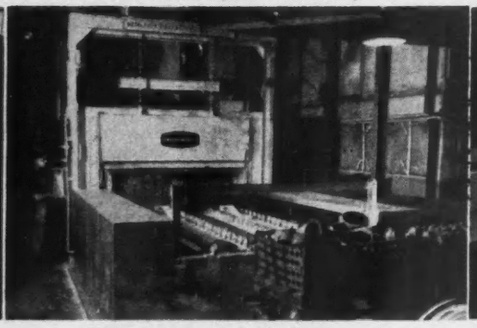

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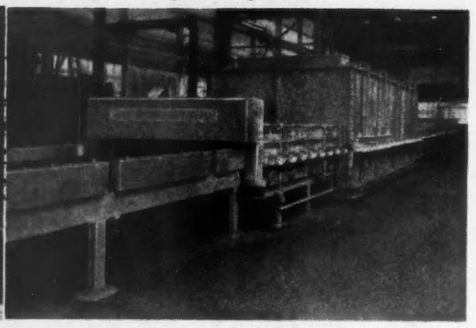

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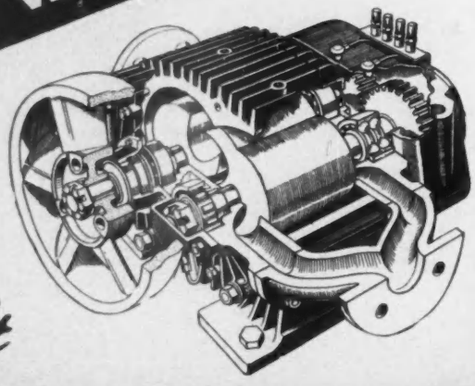

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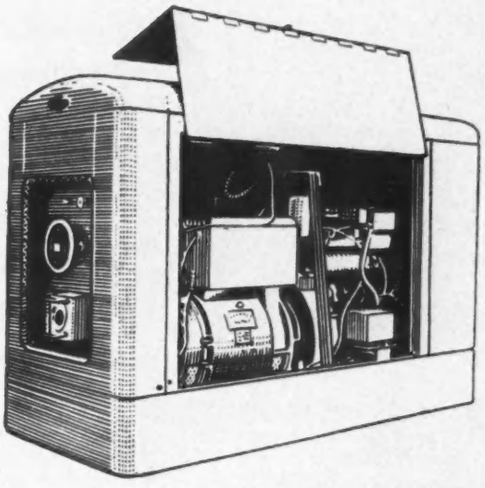

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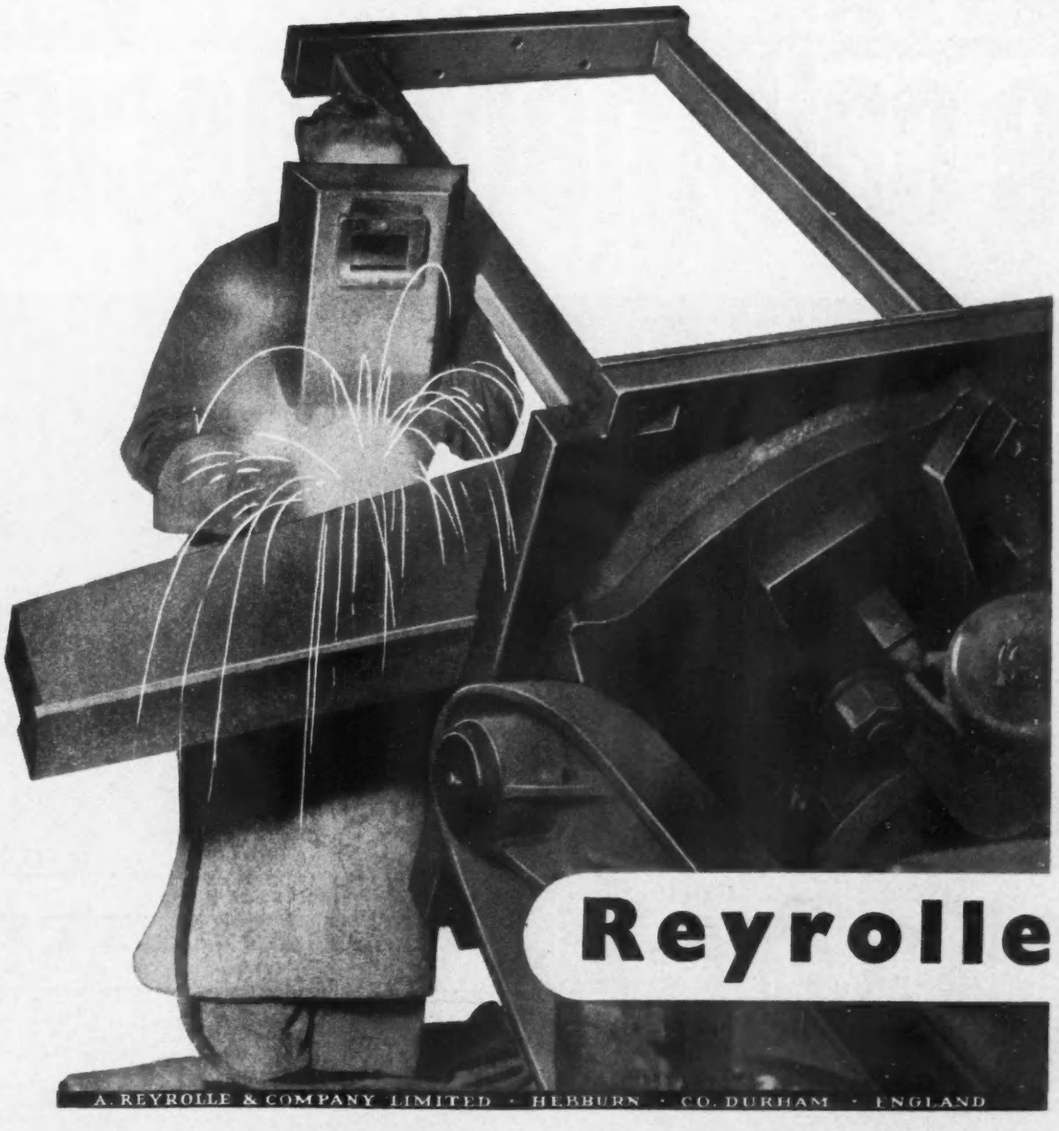

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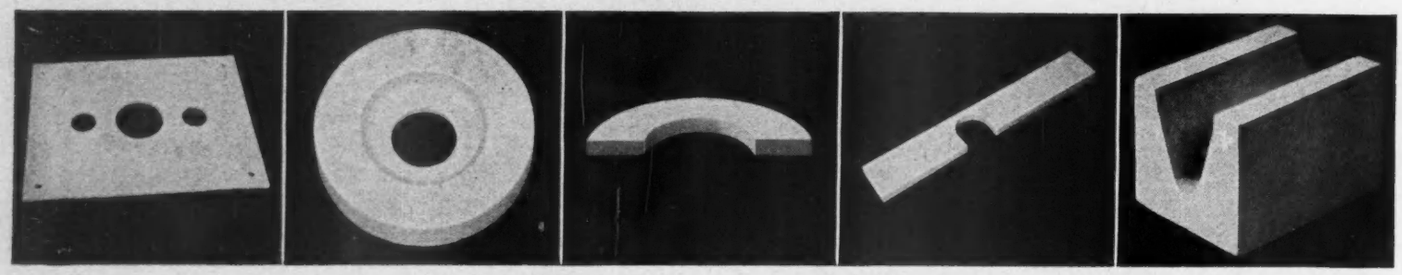

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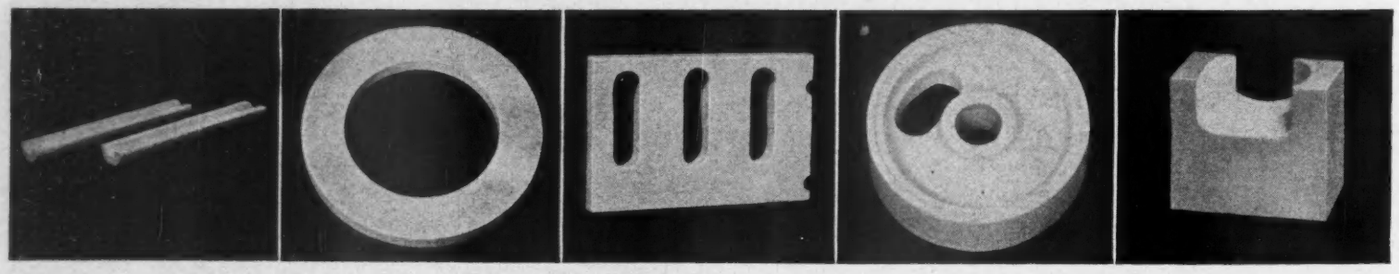

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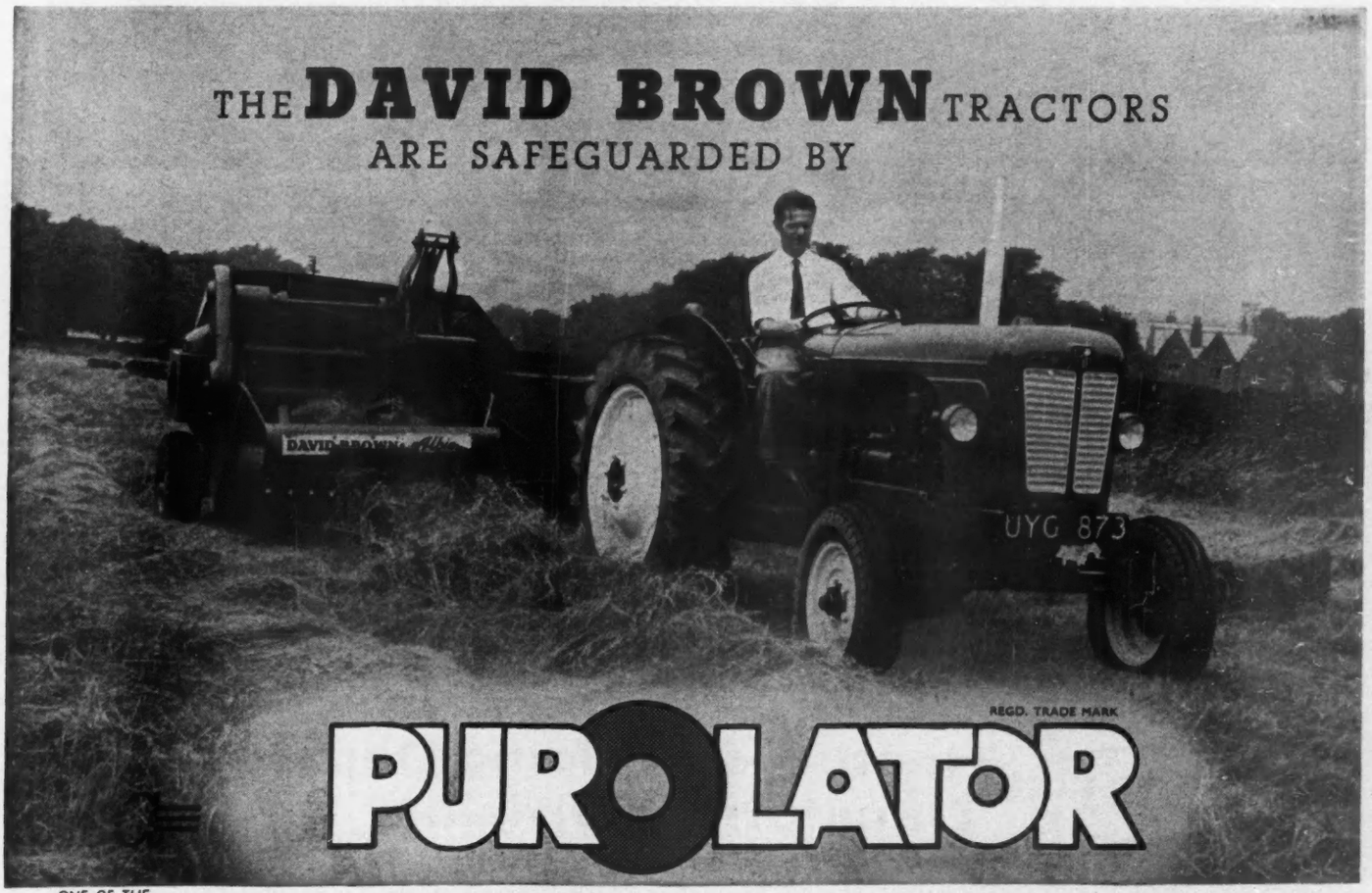

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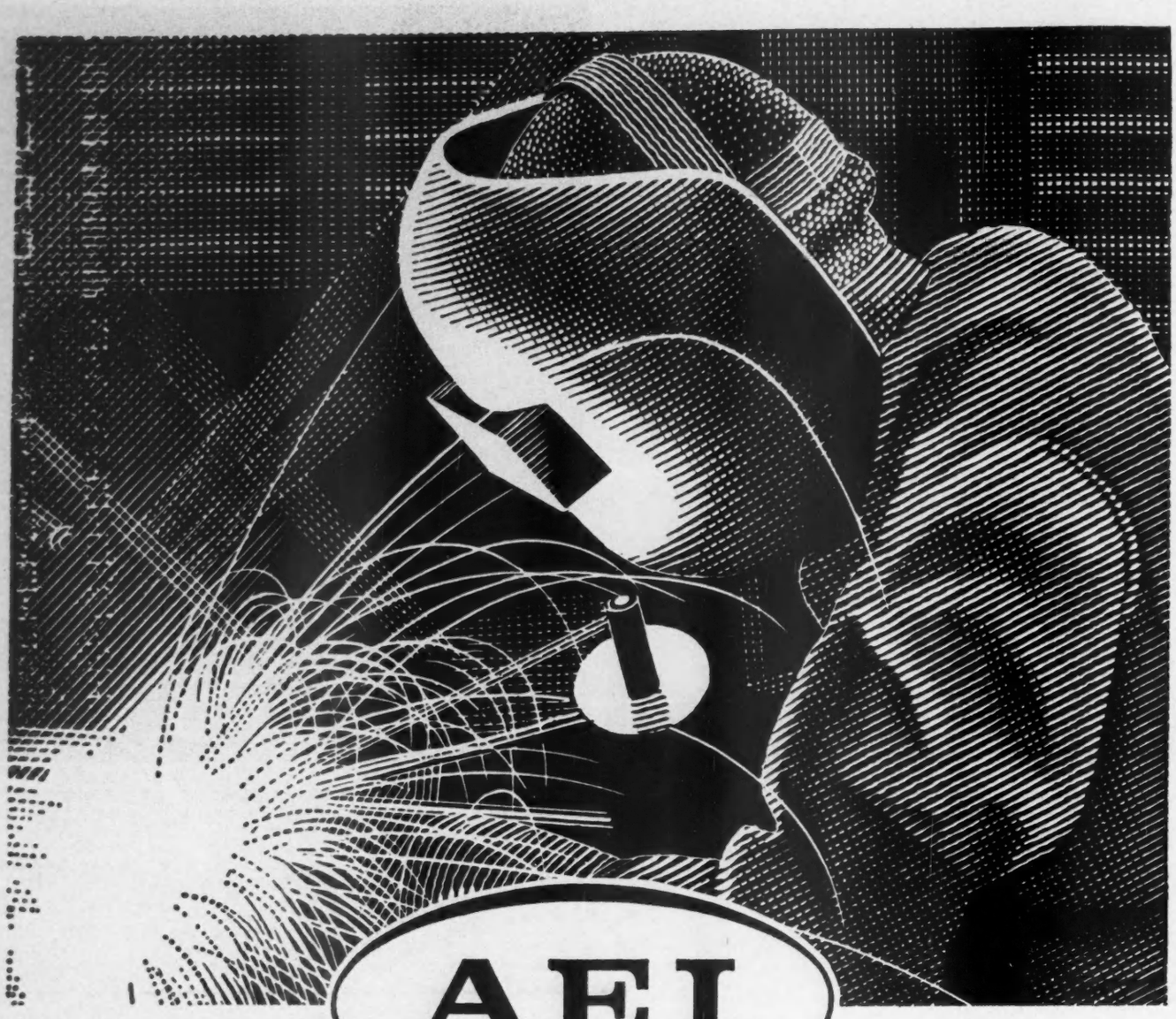

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ENGINEERING Impact

of Coordinated Research in Machine Tools

The burden of much of the criticism of the British machine tool industry has been that insufficient research is being undertaken. It was said, and presumably is still believed, that more money and more facilities should be devoted to such research.

The functions of the industry's new Research Association will be to cordinate, accelerate and initiate research projects for the benefit of machine tool design and production. The Research Association which is now being formed, and which 100 manufacturers are financing for at least five years, is sponsored by the Machine Tool Trades Association. The MTTA say that all appropriate and available existing research facilities in the United Kingdom will be used.

The MTTA are certainly correct when they say that by this means a wider range of research projects will become available to the industry than if it waited for the erection and equipment of its own laboratories. Apart from the implication, not previously made by the MTTA, that machine tools research was not going on as broadly or as quickly as it should, it may be that the present form of the Research Association should be regarded as a first step.

Its Own Centre?

Acceleration of the research of industry, university efforts as at the Manchester College of Science and Technology, research associations (PERA) and in government departments will be useful and is welcome. But it is not exclusive of other steps.

It would seem to be a reasonable assignment for the new director of research, in addition to his general duties within the present framework, to undertake the creation of the Association's own research centre. Since machine tool research and production are so often held to be closely interwoven, these facilities might best be linked with a modest production company.

It could set a very hot pace.

Heavier Spending and Greater Competition

Fully a quarter of the contractors' new orders in the second quarter of the year were for industrial development; £92 million out of a total for the quarter of £452 million.

The industrial development amount is almost a 50 per cent increase on the comparable figure a year before and it is also a higher proportion of the total.

For the contracting industry overall, the increase to £452 million for the quarter's new orders from £393 million in 1959's second quarter, was largely made up of increased work for private developers, public authorities (other than housing work) and for industry.

Provisionally estimating ahead into 1961 the Board of Trade believes that manufacturing industry will spend 20 per cent more over the year on capital investment than during the current year. 1960 is itself seeing a 25 per cent greater outlay by manufacturing interests than did 1959.

The greater part of the increased estimates are understood to come from iron and steel, chemicals, car and truck producers, paper and printing.

With the European Free Trade Association assisting the Scandinavian paper industry and with the effect of the European Common Market's Treaty of Rome upon all the others, none of these industries face anything but rising competition in the period of the capital investment forecasts.

Current United States estimates put the export of chemical products from America this year at anything up to a fifth higher than last year. While the export efforts across the Atlantic go on growing, the industrial nations of Europe, particularly Western Germany and Italy, are investing heavily in plants that need long production runs and reducing costs to yield the full benefit.

All the Eggs in One Basket?

Give the customer what he wants is an old and tried maxim of the businessman. Whether the customer knew he wanted a new car every year or a centrally heated house until he read something that left him with the feeling that by not wanting them he was letting his wife down is another matter.

Does an industrial society take any significant notice of the old adage, is a question worth asking. The British Productivity Council's booklet *Variety Reduction* quotes a number of examples in support of the principle summed up in its title. One example is the clothing concern who reduced their 50 basic styles to 16, giving longer production runs, cutting costs by as much as 45 per cent, and trebling the output. A china manufacturer reduced the number of patterns and basic shapes and so stabilised price for three years. The plastics company with 74 per cent of its business accounted for by only 8 per cent of its product list, cut down the types in low demand, and found it raised efficiency and cut overall costs.

Risking the Future

But variety reduction is a practice needing a lot of care in its application. Somewhere in all that bathwater to be run away may be some very profitable babies.

The Renault company with its concentration on the Dauphine car can now tell a cautionary tale of the fix it is possible to get into with a limited front on which to enter the commercial battle.

Throwing out today's not-so-profitable lines, in order to cream the profit off what in the end are simply the easiest lines currently being worked, not only limits the scope for growth. If the abandoned products were selling at all it means that somewhere there are some dissatisfied customers.

And businesses have a way of springing up to meet new demands. The same new producers might soon find advantages in bringing out not only the lines they had begun with but also those widely wanted money spinners which the old-established firm is concentrated upon.

Incautiously applied, variety reduction could lead to company reduction too.

of Rising Standards and Manning the Pits

The National Coal Board is in a particularly unhappy position. There could hardly be more causes for the gradual attrition of its labour force, yet a substantial price increase taking care of the recent 5*s* a week pay rise calls forth well-founded indignation at the effect on our exports.

In industry generally men are working in ever cleaner, better ventilated, thoughtfully planned conditions with less and less use for muscle power. At the same time wages rise, there have never been more people working and if distant clouds threaten from the horizon they are not yet particularly noticeable on pay night.

But for the miner the world is no such rosy place. Back breaking work can be replaced with mechanisation, but no one has yet found a way of getting coal in dust-free conditions of continuous fresh air. In many miners there is still a bitter memory of the twenties and thirties. More recently the Board have been closing uneconomic pits while the very words of the recruiting appeals are fresh in the memory.

Drift to the Top

Under all these conditions it is hard to see a reason why modest pay rises should arrest the steady drift into above-ground jobs, Yet a future coal shortage brought on by manpower deficiency will have an even more serious effect on industry than an average increase of 6*s* 8*d* a ton.

When the Federation of British Industries is able to point out that coal imported from Virginia, USA, to Port Talbot steelworks is £1 a ton cheaper than coking coal from the nearby Monmouthshire pits, it becomes worth looking at the post-war development of American coal mining.

With one of the toughest leaderships in all trade unionism, the American miners put earnings per man as their goal and not numbers of men kept in the industry. The result, with intense mechanisation, has been a slump in the numbers employed, a substantial real rise in the men's wages—and American coal competitive in price at European coastal steelworks.

While the Board concentrates its efforts on the best possible rate of output-per-man, where there have already been some creditable increases, it is for industry not to think in terms of resentment at paying a price which the Board needs to charge if it is to keep a sufficient number of men, but to spend more effort and money in getting the best performance from our one indigenous fuel.

Standardisation in Concrete Bridges

It is now ten years since prestressed concrete was first used to any extent in this country for bridge work. During those ten years pretty well every bridge that has been built—or rebuilt—in prestressed concrete has been designed entirely as a one-off job. Contractors have been faced with pricing every job separately, taking into account the idiosyncracies of each designer.

Some rationalisation will be brought about by the scheme now devised by the Prestressed Concrete Development Group. In conjunction with the Ministry of Transport they have designed a range of standard beams which, used as inverted T-sections, can be filled with *in situ* concrete to make an economical slab deck suitable for spans of between 25 and 55 ft, so covering the requirements of the majority of road bridges. More than 40 manufacturers of concrete products, well distributed about the country, will be making the standard sections. This should lead to more uniform, though still competitive, tendering in all areas. The scheme will also enable the concrete industry to share similar advantages to those long enjoyed by the steel erectors by their use of rolled steel sections.

Details of the new concrete sections are given in the Construction section of this week's issue.

and Czech Affinities on British Trade

Of all the countries in the Soviet bloc, Czechoslovakia is technically among the most advanced. Her manufacturing capacity is high; her products sophisticated and refined. The home of Skoda and a strong machine-tool industry, she shares industrial traditions with France and Britain, and in engineering retains affinities with both these countries. For this reason, Czechoslovakia, the only Communist country to participate in GATT (the General Agreement on Tariffs and Trade), should provide an admirable market for Western products, both as customer in her own right, and as a channel to other Iron Curtain countries.

So far trade with Britain has been hampered by lack of sterling, and presumably by the need to concentrate her engineering efforts on helping other Iron Curtain countries less well endowed. But the situation is changing. And a reviving fear of Germany, associated to some extent with anxiety about the Common Market, is turning Czech attention to the United Kingdom.

Report from BRNO

Czechoslovakia wants instruments, mining machinery, and plant for the growing rubber, plastics, cement and foundry industries. Sales are made through State trading organisations and direct contact with customers is difficult.

Some evidence of Czech interest is provided by recent overtures to British manufacturers. In addition, a member of ENGINEERING's staff was recently invited to visit Czechoslovakia—as the guest of the Czech authorities—in order to survey both technical and trading possibilities. He was treated very generously and impressed by what he saw. Next week ENGINEERING will publish his report.

He also spoke to British exhibitors at the Brno Fair. A firm of instrument manufacturers told him that they expected to sell every item on their stand—provided that the Czechs did not insist on barter payment.

New-Look Wood Takes a Lot of Beating

Water and chemical resistant resins enhance the properties of wood to a point where it is short-sighted to ignore the material both for mechanical and chemical-resisting applications.

With the world harvesting about 1,600 million cu. metres of timber a year it is rather misrepresenting the picture to say that "wood is being given a new lease of life." But it still does remain true that there is no need to think of timber as outdated for, say, resisting chemicals; and certainly from impregnation of redwood poles to making chipboard, this versatile material is being given technical credentials, and "rebuilt" wood laminates have very attractive properties to offer.

Improvement in mechanical properties, chemical resistance and stability is improved greatly by incorporation of synthetic glues such as resorcinol formaldehyde as an impregnant or laminating resin. This is fully realised and exploited, as for example in glulam beams (ENGNG., 1 Jan., '60, p. 6). In the following paragraphs the emphasis is on the attractive properties of resin impregnated wood, particularly regarding chemicals.

. . . In Tanning

Treated, waterproof plywood has solved a long standing problem in the Randak tanning plant of R. and A. Kohnstamm of Beckenham. Forming the access doors of large tanning drums, the plywood is successfully resisting chromic acid, lime and chemical dye solutions that have made short work of ordinary timber and even solid metal.

The doors are a new and unusual use for Permaply, the resin-impregnated plywood made in this country by Venesta Plywood. They are formed of sheet framed in gunmetal and secured by stainless steel bolts; solid brass fixings originally tried corroded and soon became useless. Dimensions are 27½ by 18 in.

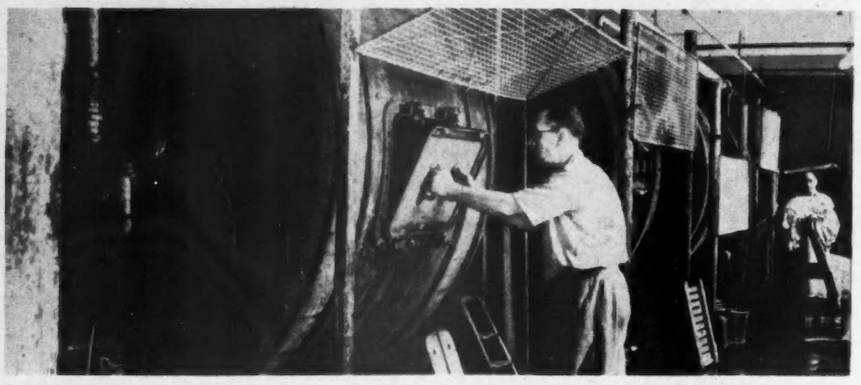
The inner surface of the doors, inside the drums, is submerged almost continuously. Under this treatment, doors made from ordinary wood quickly began to swell, warp in their frames, and finally split. The chemically-treated Permaply has remained flat and unbroken after nearly a year's exposure—a demonstration of the material's stability and resistance.

. . . In Cathodic Protection

Cathodic protection is playing an increasingly important part in preventing corrosion on external hull surfaces, and recent developments in this field are meeting with considerable success. One of the problems involved in the sacrificial anode system of protection is finding a mounting material for the magnesium anode which not only provides good insulation, but also has strong corrosion resistant properties. A material claimed to overcome this is a grade of Permali densified wood laminate, developed specially for this application.

During prolonged tests, the magnesium anode was mounted on a Permali block and the complete assembly was then placed at the low-water mark of sheet piling in Birdham Pool. Periodic inspection to ensure that the anode was working against the sheet piling showed the pH of deposits on the mounting to be 9.

This assembly was left in position for nearly two years, and finally removed when the anode had been completely consumed. At the first inspection no sign of any degradation was found on the mounting, and further laboratory tests which were carried out showed that the Permali blocks were still above their guaranteed minimum values even after two years of arduous duty. Insulation resistance measurements which were made between the holes in the panel showed values ranging from 90 to 227 megohms. After the whole panel had been immersed in water for a further 24 hours and then retested, the insulation resistance had dropped to 0·2 to 0·5 megohms—a very satisfactory result considering the length of time the panel had been immersed in water.



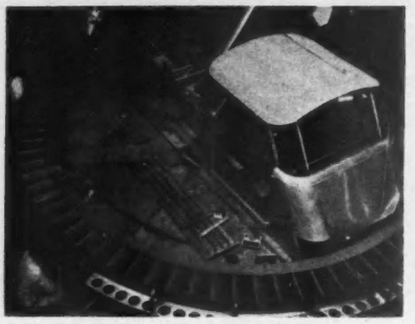
Tannery vats.

Permali also offers a potential and unusual advantage as a non-metallic fastening material in the form of bolts and nuts. Although the tensile breaking load of a new ⅜ in brass bolt and nut assembly is approximately 5,500 lb, it falls rapidly after a period of service. Whereas a Permali ⅜ in nut and bolt assembly, which has a tensile strength of approximately 4,000 lb, maintains its strength in service almost indefinitely.

. . . In Air Cushion Rotors

For the Cushioncraft built by Britten-Norman at Bembridge Airport, Isle of Wight, the peripheral rotor is of laminated timber glued with resorcinol glue made by Leicester, Lovell and Company. To give the wood greater surface abrasion resistance it has been coated with a sheathing called Cascover—using woven and treated nylon cloth, resorcinol resin and vinyl.

Covering laminated wood rotor with nylon/vinyl cloth for Cushioncraft.



. . . In Demineralisation

In the demineralisation processes of the Orange Free State mines at Goldfield, South Africa, grade BH Permali densified wood laminate has been selected as the most suitable material for construction of the frames used in the treatment of waste water. This follows intensive research into the problem and testing of other materials such as natural wood, Perspex and glass-reinforced plastic.

Control and disposal of waste water that has been encountered underground has been one of the main problems in the mine. Because it contains salts, mainly sodium chloride, it cannot be used for domestic or agricultural purposes—circumstances which unfortunately prevent the water being discharged over the countryside or into nearby streams. Before the present solution was found, its disposal proved both difficult and costly, entailing large pumping plants and pipes to carry the surplus water to distant natural pans for evaporation. In addition, the problem has been aggravated by the fact that millions of gallons of fresh water have to be brought every day for mining and extraction purposes. An effort was therefore started in 1952 to counteract these difficulties by investigating the demineralisation of brackish water by electrodialysis.

This process calls for several packs of membranes contained in frames to be assembled with a pair of electrodes. These membranes carry alternative positive and negative potential, and, when the water is passed through a narrow channel between them, the positive and negative ions of sodium chloride can only migrate through their appropriate membranes. Thus the purified water continues forward, and is used for process work, and the two ion concentrates outside the membranes are brought together to produce a concentrated sodium chloride solution which is then sent for evaporation.

. . . In Industrial Laboratories

Plywood, treated to make it more durable than solid teak, has been used for laboratory bench tops recently installed at Edinburgh University. Impregnated and predried, the plywood does not shrink, split or warp; it is rot-proof, resistant to moisture and has a tough hard-wearing surface.

The material is Venesta's Permaply. Its use in this application in preference to solid teak provides an excellent illustration of its suitability for similar duties in industrial laboratories, and indeed for bench tops in any plant where chemicals are constantly being used.

The particular type supplied to the University is ¾ in thick, and consists of laminated gaboon, impregnated with a phenolic resin and bonded to a teak veneer. Other facings are also supplied.

More Sodium Silicofluoride

ICI has increased its production capacity for sodium silicofluoride by over 50 per cent with the commissioning of a new plant at Billingham, Co. Durham. The plant is associated with recent extensions to the Billingham Division's production of compound fertiliser, and was designed by ICI personnel.

Sodium silicofluoride is used largely in the glass, vitreous enamelling, light alloy, and rubber trades; it has been in short supply in this country for a number of years, and substantial imports have been necessary. ICI is confident that it can now produce enough sodium silicofluoride to satisfy all the UK demand.

Sodium silicofluoride is a white, finely crystalline product; it is odourless, non-volatile, and only sparingly soluble in water. In constitution sodium silicofluoride resembles cryolite, for which it is an effective alternative in some applications.

The material is used as a partial opacifier in the production of vitreous enamel frits and opal glass, as a flux in the melting of light alloy scrap, as a coagulant for rubber latex in the manufacture of foam rubber, as a reagent for the extraction of beryllium from beryl, and in the extraction of rare earth metals, in the fluoridation of water supplies, and as a laundry sour or acid rinse.

Imperial Chemical Industries Limited, Millbank, London, SW1.

Butyl Rubber Plant Soon in UK

Esso Petroleum Company announce their intention to construct a plant at Fawley for the manufacture of butyl rubber. The new plant, which will cost about £4·3 million and which will have a capacity of 30,000 tons per annum, is estimated to take between two and three years to build.

The capacity of the new Esso plant, when completed, is expected to meet all United Kingdom requirements for butyl rubber for a considerable period and furthermore it will permit the company to supply export markets.

Butyl rubber was discovered in an Esso research programme to develop a form of synthetic rubber which would not deteriorate. It is well known that natural rubber and the standard synthetic rubber, SBR, which came into prominence during the war, are subject to perishing on exposure to the atmosphere and corrosive conditions.

Butyl rubber is manufactured by reacting two refinery gases, isobutylene and isoprene, and when processed by rubber companies it exhibits excellent resistance to atmospheric ageing, heat and chemical attack. Other characteristics include shock and sound absorption, negligible water absorption and therefore excellent electrical characteristics and also low gas and vapour permeability. As the permeability to air is only one-tenth that of natural rubber, butyl is universally employed for the manufacture of inner tubes.

The application of a general purpose rubber demonstrating these characteristics is diverse and growing rapidly. Butyl weather seals, sponge and sheeting are being used by the building trade and a British Standard covering the compounding of butyl rubber has been issued. Lloyd's Register of Shipping have given their approval for the adoption of butyl shipwiring cable and British Standards have issued a draft specification on this subject. Butyl covered conveyor belts, steam hose and chemical linings are all in service.

The shock and vibration absorption properties conferred by its high hysteresis are being exploited in industrial and transport applications. More particularly the introduction of the butyl tyre in the USA in which these properties give the improved riding, road holding and braking characteristics further indicate the direction of these trends.

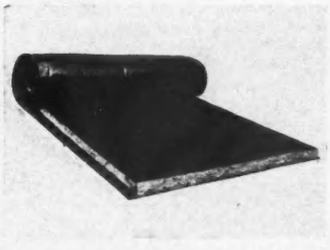
At present all butyl rubber is imported into the United Kingdom from the United States and Canada. The construction of a plant at Fawley will ease the current pressure on available supplies and assure rubber manufacturers of their future requirements of this new polymer. As an additional result the United Kingdom will become an exporter of the product rather than an importer.

Esso Petroleum Company Limited, 36 Queen Anne's Gate, London, SW1.

Underfloor Insulation

A new material for insulation of underfloor heating systems has been placed on the market by Stillite Products. The new material is Stilphon 20 and the manufacturers claim this high grade building insulation mat has been designed to the ideal specification for use as a thermal/acoustic leaf in floating floor constructions incorporating underfloor heating.

It consists of a resilient layer of fireproof mineral wool insulating and is supplied in standard 35 in wide rolls in thicknesses of 1, 1½ and 2 in. Having a covering of stout waterproof paper which complies with BS 1521: 1949 Class B the insulating mat is ready to take a concrete screed and an adequate flange is



provided along one edge of the top layer of paper to overlap and seal the butt joints.

To keep running costs to a minimum it is of course necessary in under floor heating to prevent the downward leakage of heat. The particular suitability of this new insulating material as a heat barrier is due to its ability to maintain an effective thickness, and thus efficiency, under a loading of a concrete floor screed. In this respect Stilphon 20 is manufactured at a density of 7 lb per cu. ft and has a higher content of resilient mineral wool fibre than the normal run of general purpose insulation mats.

Stillite Products Limited, 15 Whitehall, London, SW1.

Circuit Breaker Uses Plastic Dough

A new air circuit breaker, which relies solely on Rockite plastic dough mouldings for its main insulation, is now being manufactured by J. G. Statter and Company of Amersham, Bucks.

The use of Rockite DMC for these mouldings, which are seven in number, has resulted in considerable savings in production time. Rockite DMC has also facilitated new design to be incorporated thus reducing the number of loose parts to a minimum.

Three identical mouldings constitute the bases for the circuit breaker enabling each of three phases to be manufactured as a single pole assembly. By making the operating links in Rockite DMC a much greater clearance than is normally possible has been readily obtained between the live parts and earth. These links bear the full thrust of closing the circuit breaker against the considerable magnetic throw-off force inherent in the loop when closing against a peak current of 110,000 amps.

Moulded links are also used to bear the thrust of the moving contact assembly when the circuit breaker opens. Under these conditions the DMC has to withstand considerable shock forces.

The circuit breaker, known as the HAS2T, has recently been subjected to a short circuit test duty at a recognised Asta testing station. Here it successfully withstood testing for a rating of 31 MVA rupturing capacity at 415 volts to BS 116: 1952. It has been developed for use in factories, workshops, large office blocks and similar sites including on board ship—anywhere where a reliable and efficient electricity distribution system is essential.

All the DMC components are moulded by Minerva Mouldings of Amersham, Bucks., who, like J. G. Statter, are members of the Metal Industries Group.

Rockite Dough Moulding Compound: British Resin Products Limited, Devonshire House, Piccadilly, London, W1.

Plastics in a Bus

All exterior shaped parts of the new Midland Red D9 omnibus, now in service on town and country routes in the Birmingham area, have been fabricated from glass-fibre reinforced polyester resin. The D9 is the first double-decker omnibus to use reinforced resins on a very large scale, and over 100 mouldings, many of which are based on Bakelite polyester resin, have been incorporated into the vehicle. A fleet of 95 is now being built.

The front and rear panels of the D9 are made entirely from reinforced resin and the vehicle is the first of its type to be made in the Midland Red workshops as a production model. The manufacturer states that the basic idea behind the design of D9 was to produce a passenger vehicle combining maximum strength with lightness to help keep maintenance and running costs to a minimum. Reinforced resins have contributed materially to this aim for, in addition to their excellent weight/strength ratio, the plastics sections are highly resistant to superficial damage, and non-corrosive. Equally important

from the production aspect was the considerable saving in tooling costs and time.

Much of the interior of the new bus also incorporates mouldings based on Bakelite polyester resin. Other parts made from the same plastics range from the cab and emergency doors to the driver's instrument panel housing.

The D9 seats 72 passengers, and the body and chassis are of integral construction. Other mechanical features of importance include variable rate rubber suspension, power assisted steering, independent front wheel suspension and semi-automatic transmission.

Bakelite Limited, 12-18 Grosvenor Gardens, London, SW1.

Plain Words

By Capricorn

HOWEVER much we pay lip service to the merits of railway modernisation, our hackles rise at any suggestion of an increase in fares. But if it is some odd little narrow-gauge railway, going from nowhere to nowhere, we dig in our pockets and smile.

Next time you look at those rather pleasant drawings at a railway station of the progress with railway modernisation, take a moment's thought. As you draw in your breath at the bill which the nation will be called upon to pay—you included—remember that if it means an increase in fares, it may be worth it.

Most of us still like railways; most of us still admit that we need railways; and most of us have to travel on railways. But if there is one thing which disturbs the phlegm of the Englishman (or the contentiousness of the Scot) it is higher rail fares. Nothing puts the blood pressure up quicker, unless it is higher bus fares. We act as if cheap rail travel was written into Magna Carta by King John. Why?

Perhaps the beginning of the answer is that the railways are a public utility, a nationalised industry owned by an abstraction, and operated by "them." So we feel inclined to let "them" pay for it. But signs are not lacking that once a conscious pride of ownership is stirred in the British public they will cheerfully subscribe for capital expenditure on railways and pay what they would in other circumstances consider exorbitant fares.

Look at the progressive march of societies for the preservation of rural railways. The Ravenglass and Eskdale narrow-gauge railway has been sold by auction for £12,000 to the Ravenglass and Eskdale Railway Preservation Society. It is not long since the Bluebell Railway, which was closed in 1958, was taken over by a similar organisation. It charges five-pence a mile first class at week-ends, when it runs its stock on four and a half miles of track, and business has been brisk, eked out by second-class passengers paying only fourpence-halfpenny a mile. A Government monopoly could not keep out of the red at three-halfpence a mile.

The good members of these societies, who doubtless travel at privileged rates, are likely to be the backbone of the passenger traffic but why do they so cheerfully pay up? Is it love of the past and a disposition to preserve? Is it dislike of over-crowded roads? Most likely it is pride of ownership. The railway is conspicuously theirs, not simply theirs by legislative quibble. They may even have a say of some sort in how it is to be run. The annual meetings of these societies may be vigorous cut-and-thrust affairs with no quarter asked for or given.

But the big railway systems are ours too. Maybe if we could influence them more we should feel a pride of ownership and rush to their defence when next the fares go up. After all, cut-price railways mean cut-price comfort and convenience.

Letters to the Editor

Mechanical Properties

SIR, With the object of having their opinions on the subject, I should be very grateful if I may put a certain question to your readers, which I have not succeeded in answering myself. May I explain very shortly?

During the ten years prior to 1952 I wrote quite a lot in the technical and scientific press on mechanical properties, pointing out that they could be calculated from a true stress-strain curve of the material if it were supplied with a logarithmic formula connecting stress and strain; that at least is one short way of describing the nature of my work. I proved the possibility of this calculation in a sufficient number of cases to satisfy most people that my proposal to found upon the suggestion a new version of strength of materials ought, I believe, to have been taken seriously and aroused much interest.

As examples of this work, I would draw attention to two typical papers of mine, namely, "Fracture: Its Energy Distribution and Specific Energy" (ENGNG., vol. 157, 1944, p. 421), and "A New Version of Strength of Materials," *Metallurgia*, January, 1952. Could your readers give me some idea why these suggestions accompanied by quite sufficient proof of their feasibility should have aroused so little interest?

Having sown the seeds of a new idea it must be a matter of surprise, I think, that nothing at all has been done about it! Are we awaiting the arrival of a foreigner on the scene with the same idea?

Yours faithfully,
A. C. VIVIAN.

High Orchard,
Ralph Allen's Drive,
Bath.
10 September, 1960.

Satellite Payloads

SIR, Your special article, which provided an excellent review of current thinking on communications satellites (ENGNG., 9 Sept. '60, p. 340) raises interesting points on which I would like to comment. I refer, particularly, to the dilemma of which satellite to choose, and to the larger problem of Britain's entry into space research.

The question of the choice of a communications satellite was discussed in terms of the passive and active types. The passive satellite, weighing as little as 25 to 50 lb, and hence requiring only a small launcher, may now be made far more efficient than the simple reflecting sphere, exemplified by Echo 1. Use of anisotropic reflectors, new techniques in extremely high-gain antennae and higher power transmitters, and inherently greater reliability and flexibility, may make this satellite system more attractive than the heavier active type. A communications satellite which decreases the need for large payloads in orbit, and consequently decreases the need for large boosters, is attractive. This is especially important for Britain where the availability of only a large and expensive satellite-launcher, Blue Streak, greatly restricts the scope of a space programme.

The active type of satellite is exemplified in Britain by the system proposed by Hawker Siddeley, for use with Blue Streak. Its probable weight is about 700 lb and it is this size of payload, necessitating the costly use of a large launcher, which poses the main problem in Britain's proposed space programme. There is no doubt that a satellite research programme, requiring only small payloads, and hence small launchers, would greatly decrease the programme costs. It would, therefore, provide greater hope of a long-term programme, where we would have greater opportunity to determine the pros and cons of conflicting satellite systems, such as in the communications field. It is instructive, then, to see how payloads might be reduced.

The American Scout launcher provides a good example of how this can be done. It has been proposed that the Scout should launch a miniaturised active satellite, having voice and television capability and weighing only 150 lb. If such a satellite had similar capability to that proposed for Blue Streak then the range of payload weights for passive and active communications satellites might be reduced from 25 to 700 lb to only 25 to 150 lb. The launcher required for communications satellite operation would then change from the Blue Streak type to the Scout type and the programme costs would fall accordingly. Further application of the rocket and electronic miniaturisation techniques, currently exemplified by Scout, would result in even smaller satellite launchers and the prospect of an extremely low-cost system then becomes very real.

It is in this new type of approach that space costs can be reduced, enabling Britain to look forward to a long-term space programme, within its restricted research budget. For competitive space research to flourish economy of operation is mandatory, and in view of the possibilities afforded by rocket and electronics miniaturisation, I submit, Sir, that a second look at our satellite programme might be profitable.

Yours faithfully,
ANTHONY M. PEDUZZI.

58 Maltravers Street,
Arundel,
Sussex.
15 September, 1960.

Feeding Men on the Moon

SIR, Mr. G. V. E. Thompson's article entitled "Hydroponics Will Feed Men on the Moon" (ENGNG., 26 Aug. '60, p. 294) appears to be in want of reality on a number of points.

Firstly, the problem of developing a form of hydroponics for the cultivation of terrestrial plants in space is far greater than it seems to be. Plants have evolved to what they are in response to the slowly changing set of conditions on earth. The form of life and the nature of its habits, that took millions of years to emerge, cannot drastically be changed in ten years without severely damaging or destroying it.

It follows that in all forms of space hydroponics the essential requirements would be the simulation of terrestrial conditions with all its implications and including the "normal" composition and pressure of the atmosphere, light and temperature variations, the constancy of earth's gravity, and so on. The problem would, of course, increase manyfold if the process of cycling of matter were to be incorporated in such a project.

Secondly, the necessity of resorting to hydroponics as a means of providing space explorers with food is open to question. The bulk of the plant body is made up of water and indigestible solids and even if scientifically, technically and financially it were possible to employ hydroponics in space vehicles, the relatively little food value vegetables contain in proportion to their bulk would hardly justify the immense effort it would entail. Astronauts should instead be trained to learn to feed and survive on highly concentrated and pure forms of essential substances, such as sugar, fat, powdered meat, digestible protein, etc. (The Eskimos and the Masai in Kenya feed mainly on meat and fat). Vitamins, of course, should be supplied in pills.

The waste water of the crew of the space ships could be collected and purified for recirculation. The purification could be effected by chemical means or distillation and should not constitute a major problem. Rockets are being made that will be capable of lifting loads of many tons, though an astronaut's one year's food supply in the concentrated form should not exceed one ton.

Thirdly, one fails to see the purpose of estab-

lishing an agricultural civilisation on the moon, that lacks free oxygen and water. Its exploration may serve to satisfy man's curiosity of new places, and the only material benefit he could derive from colonising the moon would be in the nature of minerals. But there is no shortage of these on the earth, which is, in any case, largely unexplored for its resources.

It is food shortage that threatens the fast-growing populations and it is in this respect that the immense significance of soilless culture as a means of food production will be recognised. The moon is far from being a larder.

Yours sincerely,

S. DOMBAY.

118 Sutherland Avenue,
London, W9.
18 September, 1960.

What to Read

SIR, Mr. C. W. Hanson's analysis in his article "Deciding What to Read to Keep Informed" (ENGNG., 16 Sept. '60, p. 378) will have been read with interest by people who have to provide technical information. However, in applying it to the case of a rather unusual "individual engineer" he has, I believe, produced conclusions which are not realistic, especially in the much more common case of the engineer with pressing responsibilities, working in an organisation at least large enough to permit some degree of specialisation.

The basic difficulty is that most engineers have so many papers they must read that they cannot spend an hour a day reading for general information. Generally, such men could not be persuaded that it would be an economic use of their time to spend regularly a solid hour or so going through an abstracts journal, if it could possibly be done by someone else, and still less for a number of engineers in the same organisation to take turns in doing so. I would heartily agree with them.

A smaller, but significant, difficulty in an organisation of any size is the practical one of arranging for a number of people to see the same periodicals regularly without having to order great numbers of each. One often finds a circulation system which introduces great delays and occasionally loses copies altogether.

It might therefore have been hoped that Mr. Hanson's chief recommendation would have been that where at all possible the scanning of the literature should be delegated. Even the engineer on his own must benefit if he can send someone to a library every week to note, perhaps, all the titles in each of a dozen or two periodicals, any titles of possible relevance in several abstracts, and any likely new patents in the journal, and if several engineers can delegate their scanning to the same person there are further advantages from specialisation.

In many organisations a specialist, someone given this as just part of his job, or a qualified information man, according to circumstances, prepares a weekly guide to the literature. A copy, perhaps annotated individually, goes to each engineer. The scanning is thus done regularly, carefully, and probably skilfully. Each engineer is informed of more useful items to send for than he would have got from a limited individual scanning effort, and he can reduce his regular reading of key periodicals accordingly. I should think that two is a reasonable number. Indeed, if he has a reliable information man he can skip even these occasionally, so long as he spends ten minutes selecting items from the weekly guide.

Yours faithfully,

F. MACHON,
Technical Information Engineer.

Research Laboratories,
D. Napier and Son, Limited,
Acton,
London, W3.
19 September, 1960.

Events in Advance

Exhibitions and Conferences

Synthetic Rubber Symposium and Exhibition, Second International.—Tues., 11 Oct., to Thurs., 13 Oct., at Church House, Great Smith Street, London, SW1. Organised by *Rubber and Plastics Age*, Gaywood House, Great Peter Street, London, SW1. Tel. ABBey 7447.

Institution of Production Engineers, National Conference.—Wed., 12 Oct., to Fri., 14 Oct., in Brighton. Theme "Modern Trends in the Manipulation of Metals." Institute offices: 10 Chesterfield Street, London, W1. Tel. GROsvenor 5254.

Non-Destructive Testing of Materials, Course on.—Sun., 16 Oct., to Sat., 29 Oct. Organised by the British Council. Fee £47. Apply to the director, Courses Department, 65 Davies Street, London, W1. Tel. GROsvenor 8011.

Planning and the Motor Vehicle: National Conference of the Town and Country Planning Association.—Tues. and Wed., 18 and 19 Oct., at Church House, Great Smith Street, London, SW1. Offices of the Association: 28 King Street, Covent Garden, London, WC2. Tel. TEMple Bar 5006.

Instrumentation and Automation, International Congress and Exhibition (INTERKAMA).—Wed., 19 Oct., to Wed., 26 Oct., at Düsseldorf. Organised by the Nordwestdeutsche Ausstellungs-Gesellschaft m.b.H. (NOWEA), 4 Ehrenhof, Düsseldorf.

Chemical Effects of Nuclear Transformations, Symposium.—Mon., 24 Oct., to Thurs., 27 Oct., in Prague, Czechoslovakia. Organised by the International Atomic Energy Agency, Kaerntnerring, Vienna 1, Austria.

Iron and Steel Engineers Group of the Iron and Steel Institute, 41st Meeting.—Mon., 24 Oct., to Thurs., 27 Oct., in Scunthorpe. Apply to the secretary, the Iron and Steel Institute, 4 Grosvenor Gardens, London, SW1. Tel. SLOane 0061.

Computer Applications Symposium.—Wed. and Thurs., 26 and 27 Oct., at the Morrison Hotel, Chicago. Sponsored by the Armour Research Foundation of the Illinois Institute of Technology, 35 West 33rd Street, Chicago 16, Illinois, USA.

Federal Trust for Education and Research, Course.—Thurs. and Fri., 27 and 28 Oct., at the Londoner Hotel, Welbeck Street, London, W1. Theme: "The Progress of the Common Market and Its Effects on the United Kingdom." Apply to the course secretary, Federal Trust for Education and Research, 10 Wyndham Place, London, W1. Tel PADdington 6670.

Management Ratios and Interfirm Comparison, Half-Day Conference.—Thurs., 3 Nov., at the Federation of British Industries, 21 Tothill Street, London, SW1. Commencing at 2.30 p.m. Organised by the Harrow and Wembley Productivity Association, in conjunction with the Centre for Interfirm Comparison. Apply to Mr. A.G. Sells, Industrial Engineering Department, Kodak Ltd., Harrow, Middlesex. Tel. Harrow 4380.

Nickel-Chrome Plating, One-Day Symposium on.—Wed., 16 Nov., at the Royal Festival Hall, South Bank, London, SE1. Organised by the London Branch of the Institute of Metal Finishing. Apply to Mr. S. W. Baier, 9E Cleveland Road, London, W13.

Power and Mechanical Engineering, 24th National Exposition (National Power Show).—Mon., 28 Nov., to Fri., 2 Dec., at the Coliseum, New York. Organised by the International Exposition Co., 480 Lexington Avenue, New York 17, USA.

Meetings and Papers

British Institution of Radio Engineers

LONDON
"The Land Colour Theory with Particular Reference to Its Applications to Colour Television." Discussion to be opened by M. Wilson and W. N. Sproson. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Wed., 28 Sept., 6.30 p.m.

Building Centre

LONDON
Various technical films, exhibited by Truscon Ltd. Wed., 28 Sept., 12.45 p.m.

Combustion Engineering Association

MANCHESTER
"Modern Fuels and Their Application," by D. C. Gunn. North Western Region. Engineers' Club, Albert Square, Manchester. Tues., 27 Sept., 2.30 p.m.

Institute of Information Scientists

LONDON
"New Research at Chemical Abstracts," by Dr. G. Malcolm Dyson. Swedenborg Hall, Barter Street, Bloomsbury Way, WC1. Wed., 5 Oct., 6.15 p.m.*

Institute of Marine Engineers and Royal Institution of Naval Architects

PORTSMOUTH
"Modern Marine Applications of Refrigeration," by Lieut. Commander M. B. F. Ranken. Southern Joint Branch. Portsmouth Technical College. Thurs., 29 Sept., 7.30 p.m.

Institution of Electrical Engineers

BIRMINGHAM
Chairman's Inaugural Address, by Brigadier F. Jones; and Annual General Meeting, at 6 p.m. Conversazione, at 7.30 p.m. South Midland Centre. Grand Hotel, Birmingham. Mon., 3 Oct.

Institution of Heating and Ventilating Engineers

GLASGOW
"Heating and Ventilating in Modern Offices or Hotel Blocks with Emphasis on High-Velocity Single-Pipe Systems," by C. F. Regenberg. Scottish Branch. Scottish Building Centre, 425 Sauchiehall Street, Glasgow, C2. Tues., 27 Sept., 7 p.m.

Institution of Mechanical Engineers

COLCHESTER
Chairman's Address, by P. H. Stephenson. Eastern Branch. Red Lion Hotel, Colchester. Thurs., 29 Sept., 7.30 p.m.
GLASGOW
"Jodrell Bank Radio Telescope," by H. C. Husband. Scottish Branch. Royal College of Science and Technology, Glasgow. Thurs., 29 Sept., 7.30 p.m.
THURSO
"Jodrell Bank Radio Telescope," by H. C. Husband. Scottish Branch. Pentland Hotel, Thurso. Tues., 27 Sept., 7.30 p.m.

Institution of Plant Engineers

BIRMINGHAM
"Metal Stitching," by N. Tinwell. Birmingham Branch. Imperial Hotel, Temple Street, Birmingham. Fri., 30 Sept., 7.30 p.m.
CARDIFF
"Electric Welding Applications for Plant Maintenance and General Fabrication," by C. V. Lewis. South Wales Branch. South Wales Institute of Engineers, Park Place, Cardiff. Tues., 27 Sept., 7.30 p.m.
LEEDS
"Fuel Economy and Productivity," by K. Higginson. West and East Yorkshire Branch. Houldsworth School of Applied Science, The University, Leeds. Mon., 26 Sept., 7.30 p.m.
SHEFFIELD
"Maintenance Problems in a Nuclear Power Station," by J. R. Treharne. Sheffield Branch. Grand Hotel, Sheffield. Tues., 27 Sept., 7.30 p.m.

Institution of Structural Engineers

BELFAST
Chairman's Inaugural Address, by W. A. Plester. Northern Ireland Branch. Civil Engineering Department, David Keir Building, Queen's University, Belfast. Tues., 4 Oct., 6.30 p.m.

Reinforced Concrete Association

MANCHESTER
"Reinforced Concrete as a Material for Nuclear Reactor Containment," by T. C. Waters. North Western Branch, College of Technology, Sackville Street, Manchester. Mon., 3 Oct., 6.45 p.m.

Society of Chemical Industry

BRISTOL
"The Extraction of Metals and the Chemistry of Metals," by Professor F. D. Richardson. Fourth Robert Horne Memorial Lecture. Chemistry Department, University of Bristol, Woodland Road, Bristol 8. Thurs., 29 Sept., 6.30 p.m.

Society of Instrument Technology

LONDON
"Gas Sampling for Automatic Combustion Control," by R. Hardy; and "Smoke Density Measurement," by G. H. Laycock. Manson House, 26 Portland Place, London, W1. Tues., 27 Sept., 7 p.m.*
BRISTOL
"Looking at Control Systems with an Analogue Simulator," by S. W. J. Wallis. Bristol Section. Department of Physics, University of Bristol, The Royal Fort, Bristol 8. Tues., 27 Sept., 7.30 p.m.
CARDIFF
"Instrument Installation and Maintenance Costs," by S. W. J. Wallis. South Wales Section. Welsh College of Advanced Technology, Cardiff. Wed., 28 Sept., 6.45 p.m.
GLASGOW
"Control Equipment for Ship Stabilisers," by J. Bell. Scottish Section. Scottish Building Centre, 425 Sauchiehall Street, Glasgow, C2. Fri., 30 Sept., 7.15 p.m.
WIRRAL
"Automatic Titrimetry," by D. A. Patient. Chester Section. Administration Building, Associated Ethyl Co., Ltd., Oil Sites Road, Ellesmere Port, Wirral. Thurs., 29 Sept., 7 p.m.

Television Society

LONDON
"A Novel Approach to Colour Television," by A. F. H. Thomson. Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, WC2. Fri., 30 Sept., 7 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. An asterisk (*) is placed where it is understood that refreshments are available prior to the time stated.

British Institution of Radio Engineers, 9 Bedford Square, London, WC1. (MUSeum 1901)
Building Centre, 26 Store Street, London, WC1. (MUSeum 5400)
Combustion Engineering Association, 70 Jermyn Street, St. James's, London, SW1. (WHItehall 5536)
Institute of Information Scientists. Apply to Mr. J. Farradane, Torran, Croft Road, Orpington, Kent.
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London, EC3. (ROYal 8493)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (COVent Garden 1871)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London, SW1. (SLOane 3158)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. (WHItehall 7476)
Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. (SLOane 0469)
Institution of Structural Engineers, 11 Upper Belgrave Street, London, SW1. (SLOane 7128)
Reinforced Concrete Association, 94-98 Petty France, London, SW1. (ABBey 4504)
Royal Institution of Naval Architects, 10 Upper Belgrave Street, London, SW1. (SLOane 4622)
Society of Chemical Industry, 14 Belgrave Square, London, SW1. (BELgravia 3681)
Society of Instrument Technology, 20 Queen Anne Street, London, W1. (LANgham 4251)
Television Society, 166 Shaftesbury Avenue, London, WC2. (TEMple Bar 3330)

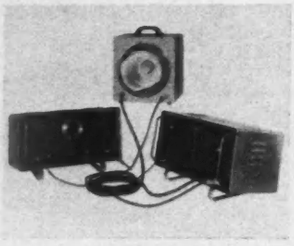
STROBOSCOPE

Slow Motion Drive

A POWER drive for slow motion viewing is one of the features of a new stroboscope, the type 1206A.

The frequency range that can be covered is from 10 to 500 c/s in four ranges, the last giving full coverage. A motor driven continuously variable phase shifter is used to provide the slow motion viewing, by introducing a constant frequency difference of from ¼ to 2 c/s. This facility is of particular value in vibration tests where it is necessary to observe in detail the individual resonances which may arise over a wide band of frequencies. The equipment is suitable for making the "Resonance Search" vibration test.

For applications up to 250 c/s a high intensity point source lamp unit is available. Where the slow motion facility is not required, the power unit and lamp are available without the oscillator. An external oscillator, having an approximately sinusoidal wave form and providing a signal between 3 and 10 volts, is required to trigger the flash tube.



Xenon tubes give a white light and have a life of at least 100 hours. The flash duration is from 15 to 40 microseconds. The equipment is intended to run from a 200-250 volts 50 to 60 cycles supply. The oscillator and power units both measure 19 in by 13 in by 11¼ in, and weigh 45 and 46 lb respectively. The lamp unit measures 10½ in by 8¼ in by 12 in and weighs 16 lb approximately. The point source lamp unit measures 7½ in by 10 in by 12¼ in and weighs 7½ lb. It can be used with a reflector and lens system to light objects at a distance. *Dawe Instruments Limited, 99-101 Uxbridge Road, Ealing, London, W5.*

AIR COMPRESSOR

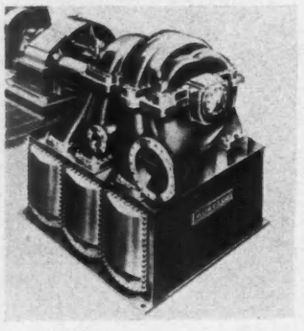
With Intercooler

SHORTLY to be manufactured in this country is the Clark range of air compressors.

The Isotemp compressors are centrifugal machines with integral air intercoolers. Six frame sizes make up the range with outputs from 5,000 to 38,000 cu. ft per minute at pressures up to 110 lb per sq. in. The corresponding range of horsepowers is from 1,000 to 8,000.

One claim for the machines is the small floor space that they require. The single case is split horizontally along the centre line and all pipe connections are located in the lower half so that they are not disturbed during inspections. The rotors are mounted on a single shaft which runs in integral bearings with labyrinth seals. End thrust is obviated by mounting pairs of impellers back to back.

The illustration shows a four stage model with three intercoolers. These are composed of fin and tube bundles. Moisture separators are included on the second and third coolers, the principle of



operation giving positive removal of the moisture as the air is turned for the next stage. The system is claimed to have all the advantages of centrifugal separation, yet in a small space. Water requirements for the coolers are low—about 2½ gallons per minute for each 100 cu ft. of air per minute with a temperature rise of 25° F. The coolers are supported on rails and can easily be withdrawn for inspection. *G. and J. Weir Limited, Cathcart, Glasgow.*

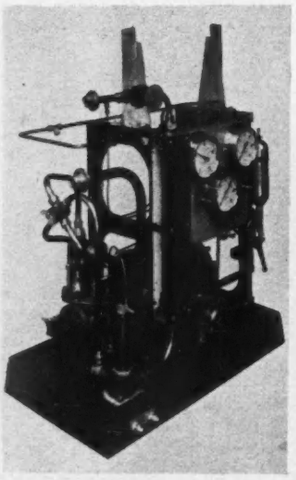
FLOW TEST RIG

For Fuel Systems

THE test rig illustrated (with the covers removed) is designed for checking fuel flows primarily in aircraft.

The flow capacity is from 60 to 600 gallons per hour and the delivery pressure is adjustable from 2 to 25 lb per sq. in. Gauges indicate the pressure drop in the system or the applied pressure when testing valves and components. There is an air leak indicator giving visual indication of the presence of a leak and also recording on a glass tube its magnitude. A methyl-bromide fire extinguisher system is installed in the casing of the instrument.

The instrument conforms to all the requirements of specification AD 144 and has been certified for Buxton Group II gases. In use it is placed beside, and at the same level as, the engine pump, and the outlet from the pump connected to the inlet of the rig which is provided with a 1¼ in female union. The outlet of the rig is then connected back into the aircraft tank. The rig pump motor is rated for 440V



3 phase 50 cycles supply. Overall dimensions are 3 ft 4 in by 1 ft 10 in by 4 ft high. *Exactor Limited, Exactor Works, Church Way, Edgware, Middlesex.*

HORIZONTAL BORER

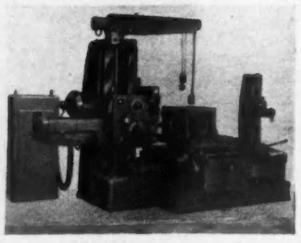
2 Ton Workpieces

WORKPIECES up to 2 tons in weight can be handled by the TOS WH80 horizontal boring machine.

A work surface up to 1,000 mm by 710 mm can be machined on four sides in one setting. The rotary table is accurately locked at 90° intervals. The machine bed is 1,480 mm broad to support the work even in extreme positions. All machine movements are controlled by levers from the same post, and fine adjustment is by hand wheel. Settings can be read to 0·01 mm on optical screens.

Setting of the cross slide for drilling holes on opposite sides of the workpiece is made easy by the measuring system employed. Vertical coordinates are set by the optical device on the spindle stock. There is an electric limit switch that enables depth drilling to be preselected to an accuracy of 0·5 mm.

The diameter of the spindle is 80 mm and the travel 560 mm. The vertical headstock on the column has a movement of 710 mm and the cross travel of



the table is 1,000 mm. The longitudinal travel is also 1,000 mm. There are 26 rates of feed from 0·02 to 6·3 mm per revolution tand 21 spindle speeds from 18 to 1,800 r.p.m. The working surface of the table is 800 mm by 890 mm and the maximum load that can be carried on it is 2,000 kg.

Both spindle speeds and feed rates can be preselected while the machine is running and engaged when required. The automatic feed is controlled by a hand lever. Movements of the spindle stock and table slide can be engaged simultaneously so that oblique surfaces can be milled. *Strojexport, 4 Upper Belgrave Street, London, SW1.*

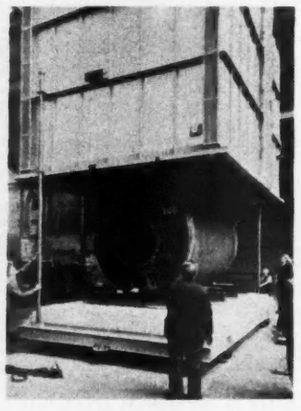
ELECTRIC FURNACE

Stress Relieving

CLAIMS for a "Top Hat" electric furnace are that the fuel costs are low and the design allows simplified loading.

The base on which the articles stand is made of prefabricated channel and steel plates, insulated with firebricks through which electric heating elements are inserted. The upper, top-hat, portion has steel plate sides and is lined with insulation material attached by heat resisting rods and hooks. Sides and roof are fitted with heating elements. The roof can be constructed either as a flat top or as an arch.

The heating elements are heavy gauge alloy with porcelain tubes passed through the coils for added stability when very high temperatures are used. Heat control can be by transducers or saturable reactors, a non-electric infinitely variable control which may be set to a programme by a time-temperature controller. A galvanometer at the control panel feeds a small direct current to the transductor according to the pre-



determined programme curve. Control is to fine limits. The range of sizes in which the furnaces are made is from 15 cu. ft up to 2,600 cu. ft. Larger sizes can be supplied and in general the furnaces are custom built. *Shelley Electric Furnaces Limited, Longton, Stoke-on-Trent, Staffordshire.*

DRILL STAND

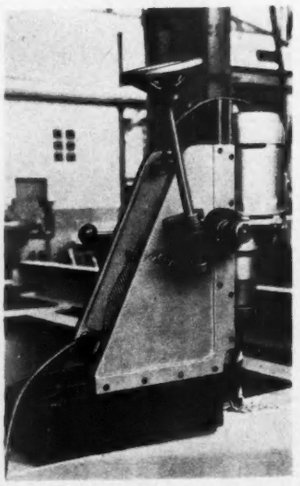
Magnetic Fixing

NOW on the market is a magnetic drill stand; it is made in several sizes, the largest of which will hold drills of up to 1½ in capacity.

The Magcodrill comprises basically a magnet and drill holder, the latter being able to take any type of drill—air, electric, or high frequency. The stand is placed approximately in position and plugged in to the electrical supply with the field control set at the minimum. This field will hold the stand lightly but will allow movement for final positioning. When the drill has been centred, the control is turned to "full," clamping the stand firmly in place.

The stand can be used in the horizontal or vertical position, or overhead if necessary. A safety chain is provided for use in the latter case. A worm and wheel is used to advance the drill into the work.

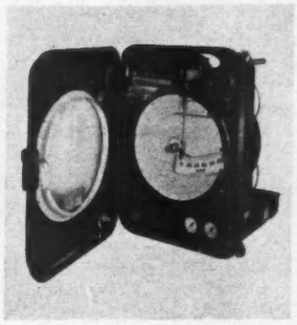
Models are made for any voltage and for alternating and direct current supplies. On certain models a facility for a 1 in change of radius through an angle of



350° is available. The one illustrated is the MD2 which has a capacity for drilling up to ¾ in diameter. *Magco Limited, Lake Works, Porchester, Hampshire.*

FLOW METER

Ring Balance Type



THE range of ring balance flow meters made by the Hagan Company is now available in this country.

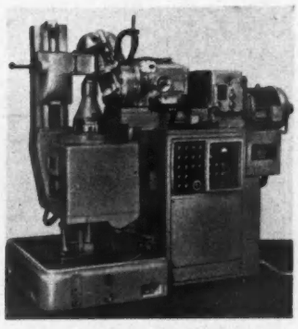
The ring assemblies on these meters are interchangeable to provide full scale ranges of from 0·5 in water gauge to 560 in w.g. differential, and for static pressures of from 5 lb per sq. in to 6,000 lb per sq. in. Facilities exist for adjustment of any one ring over a 3 to 1 differential range and the meters can be fitted with pneumatic or electric transmission as required by the indicator or recorder.

The differential pressure produced at the measuring point in the main flow is brought to the toroidal ring of the meter by flexible S tubes. A feature of these tubes is that their configuration and metal-to-metal fittings provide safe and completely flexible connectors which preserve the meter's high inherent sensitivity throughout the range. The system also allows the meter to be calibrated under operating static pressures without disconnecting any pipework.

Other features incorporated in the meters include pressure and temperature compensating devices; up to two flow measuring elements and four recording pens in one meter; the integrator is easily checked and readings taken without opening the case; no mechanism is in contact with the fluid; and calibration is independent of the density and quantity of the sealing liquid. *Hagan Controls Limited, 14 Grosvenor Place, London, SW1.*

GEAR HOBBER

200 mm capacity



A GEAR hobber of 200 mm capacity fitted with programme control has been produced by the Czechoslavokian firm TOS.

Spur, helical, and worm gears can all be cut on the OFP1 machine provided their diameter does not exceed 200 mm and their module 4. A stop system is used for the sequence programming which covers speeds, feeds and the number of passes made. Rough cutting, finish cutting, climb hobbing and conventional hobbing are all included.

The hob rotates at speeds from 63 to 400 r.p.m. with feeds from 0·4 to 100 mm per minute. The feeds of the clamping table are infinitely variable from 0·62 to 200 mm per minute. Hydraulic operation is used. The tool speed is changed in steps in geometrical progression.

Uniform wear of the hob is obtained by a shifting hob slide. The number of axial shiftings of the hob in steps is determined by the module tooth number and pitch, as well as the pressure angle and length of hob. The shifts take place automatically after the predetermined number of blanks has been cut. When all steps have been made the hob returns to its original position, and the action is repeated. Alternatively a signal is given to sharpen the hob. Chips are washed away by the coolant and when cutting is complete the direction is changed to wash the chips into one or other of two reservoirs from which they can be cleared alternately. *Strojexport, 6 Upper Belgrave Street, London, SW1.*

REEL FEEDER

Electronic Control

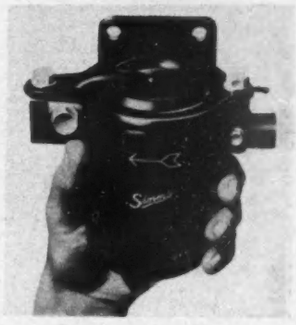
AN electronic controller for a reel feed unit allows for intermittent or variable rates of take-off.

The Reelomat is designed for feeding continuous paper forms to a processing machine. The reel is supported on a frame and the web is threaded over a jockey bar at the bottom and thence into the processing machine mounted on the top of the frame. The jockey bar is mounted on a yoke, the position of which determines the speed of the drive motor. The drive is of the peripheral belt type, the belts resting on the surface of the reel under the weight of the drive unit which is hinged on a bar above the reel.

As the web is drawn into the processing machine, the jockey bar is raised causing the feed motor to come into action, move the paper forward and relieve the tension so that the bar returns to its starting position. Plug braking on the motor prevents overrun of the reel, and tension in the web is kept at a uniform low value. The unit will take reels up to 19½ in diameter and up to 20 in wide. The feed rate is from zero to 19½ in per second. *A. J. Catlin Limited, Jasper Road, London, SE19.*

FUEL FILTER

Particles Less Than 2 Microns



PARTICLES of less than 2 microns can be removed from fuel oil by a new filter that is fitted with an impregnated paper element.

With a test fuel contaminated to provide 92 per cent of particles of less than 2 microns, the filtration efficiency is 98 per cent. The resin impregnated paper is also water repellent and therefore water is also filtered from the fuel. The use of high density paper makes it possible to use a large quantity in a small space and thus obtain the maximum filtration area in a conventional size. Element life is long.

The filter consists of a diecast aluminium body with a pressed steel cover held by two bolts. The fuel enters the housing through a boss at one side and then passes through the element. Clean fuel collects in the centre of the element and flows through the duct at the top to the outlet. An extension of the duct creates a compartment where a considerable amount of air can collect without danger of it entering the pump.

The nominal flow rate for the filter is 5 gallons per hour.

Changing of the element has been made as easy as possible by eliminating all seals, springs and other misplaceable items. The cover is removed and the element drawn out. The new element which contains the protective passage for the clean fuel forms its own seals and can be inserted without entry of dirt. *Simms Motor and Electronics Corporation, Oak Lane, East Finchley, London, N2.*

VERTICAL LATHE

Punched Card Control

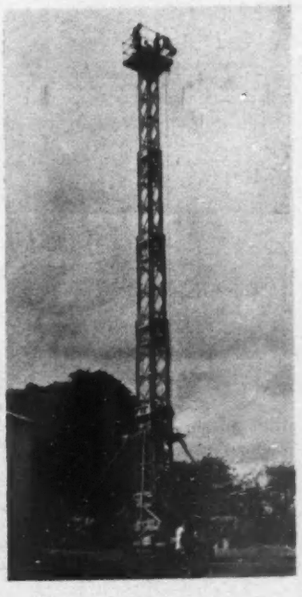
THE MAS semi-automatic vertical lathe type SPK63 is intended for turning complex shapes using programme control.

The machine has a capacity for turning work up to 630 mm diameter and 250 mm long. It is equipped with two copying and one recessing carriage. The slide of the left hand carriage has a stroke of 670 mm and a copying stroke of 315 mm in the vertical position. The left hand carriage has a vertical slide movement of 420 mm and horizontal adjustment of 100 mm. The cross stroke of the slide is 390 mm. The recessing carriage has a vertical and horizontal stroke of 260 mm.

The spindle is driven by two motors through planetary gearing, a hydraulically operated friction clutch and reduction gear. Sixteen speeds are obtainable with 8 automatically changed steps. The standard range is from 22·4 r.p.m. to 710 r.p.m. and the low range is from 14 r.p.m. to 450 r.p.m. Feeds range from 7·1 to 1,000 mm per minute with an automatically changed ratio of 10 to 1. Operation is hydraulic and programme selection is made by master punched cards on to position pins on the selector cylinders for each carriage. As many as 36 operations can be set up at one time. *Strojexport, 6 Upper Belgrave Street, London, SW1.*

MOBILE TOWER

Self-Erecting



WITH a working platform height of 81 ft, a mobile tower will retract to a travelling height of 11 ft 3 in.

The tower consists of five telescopic sections mounted on an electrically powered crawler chassis. For travelling, the sections are retracted and then swung down by twin double acting rams to lie horizontal on a subframe pivoted on the chassis.

After levelling by jacks, the four stabilising legs are extended by small hydraulic rams, positioned and then set firmly by another double acting ram to embed the spiked feet in the ground. The sections of the tower are then extended by a pushbutton control on the platform which brings into action a double acting ram with a 14 ft stroke. This is attached directly to the first two sections only and movement is imparted to the others by a system of ropes and pulleys. Track pressure with a working load of 660 lb on the platform is 1·4 lb per sq. in. *F. Taylor and Sons (Manchester) Limited, Salford, Manchester.*

Industrial Man Through a Dramatic Lens

The camera of Walter Nurnberg, dedicated industrial photographer, illuminates not just the industrial scene but the whole pattern of man in the world of industry.

A NEW peak in the eventful career of Walter Nurnberg, doyen of British industrial photographers, is reached with the selection of his distinctive work to appear in the Cologne Photokina, the International trade fair of the camera world.

Photokina opens on 24 September, extending into October. Among group stands, to which a number of photographers have been invited to contribute, and the stands of other internationally known camermen, Nurnberg has been given an area of generous scope for his 50-picture display on the theme " Men and Machines."

His personal history is important. Born in Berlin in 1907 he first followed the family profession and worked as a banker and as a member of the Berlin Stock Exchange. After six years in finance he began to study photography at the Reimann Art School in Berlin. It was at this period that he came under the influence of the work of the great German photographer Albert Renger-Patzsch. Subsequently Nurnberg has moved sharply away from the classical approach of Renger-Patzsch.

As did so many others, Nurnberg left Berlin in 1934 and set out in the Britain of the mid-thirties to become an industrial photographer. A naturalised British subject, he spent the war years with the Army.

As with painters, so with photographers. It by no means follows that the finest executants can understandably explain what they are trying to do, or why one picture is instantly a success, another only slowly reveals itself, or still another fails to communicate anything of value.

Travelling around great British industrial groups, or conducting assignments at little local works, Nurnberg has gained considerably more than a nodding acquaintance with the shop floor, with the research laboratory, and with the front office. He has detected that one of the significant changes from the world of a century ago is in the loss of the family's close contact with the working life of its head.

When the blacksmith's forge was alongside his home and the miner came straight home, with the pit dust still to be scrubbed off him, men-at-work and men-at-home were not so widely separated as is now more than common. Pit-head baths and like developments are obvious improvements, but the degree of separation between a semi-detached house in Chingford and the Ford production lines at Dagenham is almost total and by no means a good thing.

And this is where Nurnberg believes that photography can, and does, play an important—linking—role.

Public relations faces in two directions. Outwards towards the world and the customer; inwards towards the men who make up the particular concern. The really well produced house journal, with photographs that are something more than a record of the summer outing, has a place that could be of profound importance.

The amateurish shot inside or outside the works is not going to establish any improved relations or understanding. But the relationship between a worker and his machine, or the complex of tensions and the exchange of ideas between a team of engineers struggling with a problem, these things, caught in picture, communicate the life that goes on behind the impersonal wire gate.

Through well illustrated company reports, by informative and carefully prepared photographs in their advertising, many companies of all sizes are endeavouring to tell the public what they do. At no time in the history of the United Kingdom's industry has so much effort and money been put into putting across to the people, who, after all, are the customers, what goes on in industry, what the equipment and the factories look like, what other people than the chairman look like too.

In all of this Nurnberg plays an important part. As reflection on his eight years of cover picture contributions to ENGINEERING may recall, it is his especial gift to bring out the controlled caution in the face of the girl taking a sample of heavy water for analysis in the industrial chemistry group at Harwell, to catch the relaxed confidence and poise of a skilled hand engaged in casing a high quality watch.

Nurnberg does not believe that machines need dwarf people, nor be allowed to run their lives, Repeatedly his pictures show the skilled man in control, following a pattern, milling under exacting conditions, moving the fuel elements in PLUTO at Harwell. When a standard work comes to be written on ergonomics, the relationship between a man and his machine and working conditions, then it could well be illustrated by a selection from the works of Nurnberg.

For Men and Machines at the Photokina, Nurnberg has chosen a series of panel headings. They give their own indication of his thinking. Among them are: Man in Perspective, The Old Crafts, The New Alchemy, The Skilled Eye, The Industrial Drama, and The Soul of Industry.

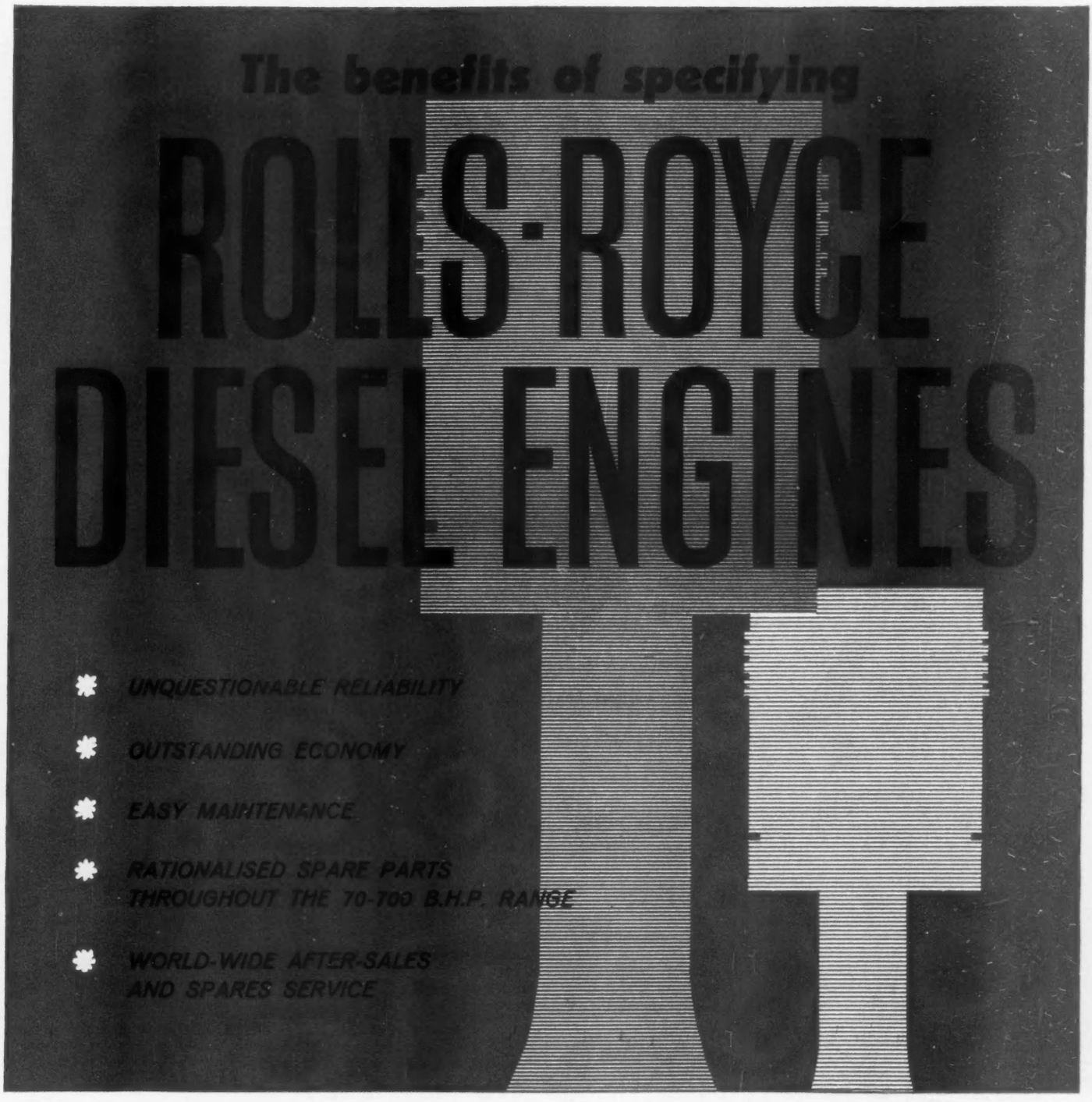
The 49 photographs of the Men and Machines display (one of them appears twice over) are not individually captioned. In this case there is no need for it. There are moments, when an observant man is watching another man at work, when the observation of some third party would be almost certainly unwelcome.

So it is with the best of Nurnberg.

It is not possible to draw Nurnberg into committing himself to views on the way photography, serving industry, may develop. Tactfully there is a suggestion that there are many who have yet to catch up with the practices of the most enlightened firms. And that those who budget in tens of thousands for half page advertisements here and full pages there are not wise when they throw the effect away by using some ill-considered and worse executed picture.

(Left) Skill and reliability in a Consett steelworker.

(Right) Architectural effects among David Brown gears.



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THE SIGN OF GOOD WELDING

Human Element

Factories Act Sections on First Aid and Cleanliness

IMPORTANT sections of the Factories Act, 1959, on cleanliness and first aid are the subject of a recent Order made by Mr. John Hare, the Minister of Labour. The section on cleanliness will come into force on 1 January next year and the first aid provision on the following 1 July.

Section 1 (Cleanliness) amends the 1937 Act and allows the Minister to prescribe materials other than oil paint for decoration of certain parts of factories. With it goes the power to require that these parts shall be repainted more frequently than once in every seven years.

Section 19 (First Aid) defines standards of training for those in charge of first aid boxes in factories employing more than 50 workers.

From next July those with first aid responsibilities will have to be registered nurses, enrolled assistant nurses or people holding a certificate of first aid issued not more than three years earlier by one of the training organisations. These are the British Red Cross Society, the St. John Ambulance Association and the St. Andrew's Ambulance Association. It is provided that the Chief Inspector of Factories may approve other training organisations with comparable standards.

The names and qualifications and date of the last approval of the evidence of their training of those responsible must be kept with the register maintained by the works under the Factories Acts.

There is a period of grace until December, 1962, in which anyone who held a certificate in first aid from a training organisation issued in the ten years before the date of the Order (13 September, 1960) will be accepted as properly trained.

A Lamp to Save a Life

As the September nights close in it is worth recalling that although the road casualty statistics of the crowded summer are given great publicity, the less well known death roll in October, November and December is much longer—in 1959 longer by 500 deaths.

The biggest single reason is the longer period of darkness. The Road Research Laboratory has shown that both in number and severity street accidents at night can be reduced to the day-time level by bringing the lighting up to a high enough degree.

Since it has also been calculated that the estimated national cost of the extra lighting needed would be no more than the costs of the accidents averted, there would be a clear gain in lives saved and injuries avoided.

Despite the simplicity of this argument many local authorities persist in switching their street lights off after 11 p.m., midnight, or one in the morning. Now the Electrical Development Association, in an excellent booklet, *Street Lighting; The Changing Scene*, has set out the comparatively small extra cost that all-night-lighting would involve for those boroughs who decide to follow the existing practice of four out of five of the London metropolitan boroughs.

The table (costs for one lamp standard) shows how small is the economy of part-night lighting, particularly when it is borne in mind that street lighting in Britain costs an average of only *7s 2d* per head each year.

	All night operation 4,000 hrs	Half night operation 2,000 hrs
Fixed costs, capital, interest, mantenance	£5	£5
Electricity and lamp replacement	£3 10*s*	£1 15*s*
Total	£8 10*s*	£6 15*s*
Cost per 1,000 hrs of lighting	£2 2*s* 6*d*	£3 7*s* 6*d*
Extra cost for each 1,000 hrs additional lighting to dawn ..	17*s* 6*d*	

Safety at Work —Some New Risks

Collisions between the jibs of cranes in use on building sites, and imported machinery whose designers have, understandably, not been in consultation with the Factory Inspectorate are two risks to safety referred to by Mr. T. W. McCullough, the Chief Inspector of Factories, in his annual report for 1959.

The total of accidents during the year increased from 167,697 to 174,071 but the deaths fell from 665 to 598, which may be a reflection of a decreasing number of severe accidents in industry. The number of deaths was the lowest recorded this century but the total of accidents reverses the tendency of the three previous years in which the number had fallen.

Given the increasing level of production and the increased number of those at work the fact that the number of accidents did not rise further suggests that the efforts being made to create a more general safety consciousness through talks, films and house magazines must have had some effect.

More Youths Hurt

The Chief Inspector points to a disturbing factor, the increase from 9,838 to 11,001 in the number of young people injured. There was no rise in the number of young people employed sufficient to account for this but with the greater numbers of young people about to leave school and enter employment there is obviously a need for some extra effort to prevent this tendency becoming more pronounced.

Safety training for new entrants must be intensified, says the Chief Inspector, not only in industry but in secondary schools, technical schools and colleges. The first year at work is the danger point, this is the period when the new worker has not had the experience of seeing a colleague maimed by an incautious movement and also the time when the young worker does not readily see that safety precautions are not just a bore but are important for self preservation.

Works of engineering construction reported 2,875 accidents, against 2,329 in 1958, although the number of deaths fell from 51 to 48. In this section there were 229 accidents with lifting appliances, and seven of these were fatal.

More accidents were reported from building operations than in any year since the war—15,410. Again the number of fatal accidents, 169, was down on the previous year and less than the ten-year average of 188. Falls at building operations accounted for 35 per cent of the casualties and 66 per cent of the deaths. Lifting apparatus accidents in the building section accounted for 443 reports, 14 of them involving deaths.

Safer Electricity ?

For the past ten years the accident figure connected with electrical equipment has fluctuated around 734. Last year the total was 738 with 34 deaths (38 deaths the previous year). Since the industrial use of electricity has expanded enormously during this period there is a reflection here of the improvements made in design and in standards. Less optimistic a picture is the particularly high rate of deaths due to contact with overhead electrical transmission and distribution lines. These caused ten out of the 34 deaths.

Machinery makers are more frequently consulting the Inspectorate than in the past and this must tend towards the more general use of shields and other guards. While this is particularly true of the printing industry, where automatic feed-in is saving dangerous exposure of operatives' hands, it is also true of the same industry that much equipment is being brought in from abroad. The Chief Inspector suggests that as such machines are usually installed before they come to the authority's notice the foreign manufacturers' agents should take a hand. Mr. McCullough would like the agents to point out to the manufacturers the importance of providing adequate fencing. The agents should also recognise the value of consulting the Inspectorate in order to reduce flaws at the design stage.

Crane Collisions

A familiar sight in the urban scene is the giant crane towering above the swiftly rising office or flat block. Almost as familiar is the sight of two such cranes, and there have been collisions. The report recognised that such collisions have not yet been serious but there is an obvious risk here. Several firms are investigating methods of keeping horizontal jibs at levels where they may pass over and under each other. This would not avoid the risk of fouling the crane ropes but the much greater hazard of jib-collision would be minimised.

Who Works Where ?

Curiously, in a period of expansion, the number of factories registered has declined, from 223,085 to 222,117. This change has occurred very largely in one sector. The number without mechanical power has dropped from 13,289 to 12,408.

Although only four factories in a thousand employ more than 1,000 people, a quarter of all registered workers were in factories of this size. The executive who recently expressed the view that ten men working together in "a scruffy little place" are often happier than in a big, modern plant may well reflect on the fact that while factories employing less than ten people account for two-thirds of the total workplaces they employ only a thirteenth of all factory workers.

Proposed Charter for Industrial Relations

One of the most important contributions since the war to the world of industrial relations has come from the National Union of Manufacturers.

The NUM's proposed Charter of Industrial Relations is the result of five months of hard work in which a sub-committee has drawn on its own direct experiences and has met trade union leaders, other employers and men working on the shop floor.

The sub-committee has been led by Sir William Robson-Brown, the Conservative M.P. who last March tabled, with some of his colleagues, a Commons resolution on the subject of labour-management affairs. That (undebated) motion put forward a number of ideas including one that some local disputes should be handled by neutral committees, a practice which already has parallels in the steel industry.

It is known that among employers, more and more faced with the necessity of meeting foreign competition by getting the last possible fraction of production from their works without raising unit costs, there has been serious concern at a number of developments in the labour field. One of the most prominent has been the disruption of delivery dates and overseas confidence by unofficial strikes. At a deeper level some employers are concerned at the gap between the men on the floor, sometimes easily led, and the higher leadership of the unions which in many cases subscribes to the same targets of productivity and export drive as the employers.

Nothing of substance has yet come from the Conservative Party's election pledge to sit down and look at labour-relations with those concerned. One way or another a new climate, and positive effects, may well flow from yesterday's Charter from the manufacturers.

Three Day Conference on Ergonomics

Senior staff from the engineering, chemical, food, steel and transport industries will be among the three hundred people attending next week's Ergonomics Conference in London.

Organised by the Department of Scientific and Industrial Research, who define ergonomics as the application of science to the problem of fitting the job to the worker, the conference will also be attended by representatives from the trade unions, research associations, the universities and Government departments.

The three day meeting, beginning on 27 September when it is opened by the Minister for Science, Lord Hailsham, is accompanied by an exhibition of practical examples. Although ergonomics is in its infancy its findings have been applied to a variety of industrial problems, from the measurement of metal and physical work and the prevention of accidents to the design of machine controls and instrument panels.

Tenders: Soft Spot of Heavy Contracting

Nuclear tenders are submitted in full detail for every inquiry and are therefore expensive. To meet costs, the nuclear groups seek compensation for abortive tenders. Their proposals may set the pattern for heavy contracting.

By B. G. Bodroghy, D.I.C., B.A.Sc.

IN JUNE this year representatives of three nuclear groups met members of the Central Electricity Generating Board to put forward an unusual request: the nuclear contractors were seeking financial compensation for unsuccessful tenders submitted to the Generating Board. The amount is in the range of £100,000 per tender.

It is not at all accepted practice that a customer should pay unsuccessful bidders for the favour of having submitted a tender; the loss of a tender is usually regarded as a normal business risk. Certainly the Generating Board makes no such compensation to its suppliers of thermal or hydroelectric power equipment. Why then should the nuclear industry be treated differently? A closer look at the structure of the industry reveals that not only is the business of nuclear contracting unlike any other, but that the nuclear groups have a powerful case to argue before the Generating Board.

Perhaps the closest analogy to the art of nuclear contracting is to be found in civil engineering, bridge building in particular. To some extent the same is true of package export deals, now becoming increasingly common, where a comprehensive tender is submitted for a complete factory. Both require very substantial capital investment in the span of a few years, and the number of orders placed is very limited. At best only three or four may be expected in a year. But an entirely new design must be prepared for every tender; repeat orders are the exception.

In view of the broad similarities between these fields of contracting it is interesting that the estimated direct cost of submitting a tender varies between ¼ and 5 per cent of the contract price in both cases. It is equally interesting that civil engineering firms have also raised the subject of financial compensation for abortive tenders in the past, but were generally unsuccessful. An exception is the earth dam of the Volta River Project, where the Ghana Government have agreed to compensate certain unsuccessful bidders in order to ensure wider participation. The award is £G2,500 per tender.

The problem of the nuclear groups differs from that of the civil engineering contractors both in magnitude and kind, in spite of the similarities enumerated above. The explanation lies in the nature of nuclear tenders, and the structure of the nuclear industry.

Two distinct, although in some cases overlapping, nuclear industries have grown up side by side in the United Kingdom. In response to the nuclear power programme of 1955 a number of industrial groups created independent companies, the so called nuclear consortia, for the specific purpose of designing natural-uranium graphite-moderated reactors. Although the companies holding shares in a consortium may have wide interests outside nuclear engineering, it is important to bear in mind that as far as the consortium is concerned, its sole commercial undertaking is nuclear contracting. For this purpose a consortium may maintain a staff of over a thousand specialist employees.

In parallel with the "graphite boys," a second nuclear industry came into being at the time when nuclear marine propulsion appeared to offer hope for considerable business. The parties involved tend to be individual companies —often shareholders in a consortium—or loose associations between a few companies. Often, although not invariably, the nuclear know-how is obtained through an association or licence agreement with an overseas company, generally in connection with a reactor using enriched fuel.

Both industries, the graphite reactor and the enriched reactor specialists, are seriously troubled by the cost of abortive tenders, but their problems differ sufficiently to warrant separate treatment. The difference arises chiefly from the fact that while the graphite companies have transacted considerable business, and are assured of at least a minimum volume in the future, the enriched fuel reactor companies have often tendered, but so far without making a single sale, and are looking to an uncertain future.

FROM MONOPOLY TO CARTELS

From the birth of the industry in 1956 to the end of 1960 the graphite groups have contracted to build eight "commercial" power stations totalling 2,725 MW(e). Five of these stations belong to the Central Electricity Generating Board, one to the South of Scotland Electricity Board, and two stations are for export, one each to Japan and Italy. Of the total ordered, the export contracts account for only 350 MW(e).

The imbalance in orders would not by itself give the generating boards a virtual purchasing monopoly; it is the future outlook that puts the burden of supporting an important industry solely on the generating boards. The United Kingdom Ministry of Power is publicly committed to ordering roughly one nuclear power station every year, ensuring a steady demand of 800 to 1,000 MW(e) annually. But there is not a sparkle of hope for such a steady demand anywhere abroad within the next few years.

The main source of trouble is that nuclear power is not yet in a position to compete with the price of conventional power except in certain energy-poor areas. There are thus two export possibilities open. Industrialised countries which are in a hurry to catch up with the leading nuclear powers find it advantageous to buy ready-made experience in the form of complete reactors from foreign manufacturers. Japan, Germany, and Italy are examples. But the prospect for repeat orders from these countries is remote, as the aim of the initial purchase is admittedly the establishment of a home industry. Both Japan and Italy have decided to buy one each of the leading reactor types and will be content to examine their performance until such time that nuclear power becomes competitive. By then, it is hoped, a competent home industry will have crystallised around the foreign nucleus artificially introduced.

The market in underdeveloped areas has a more immediate economic justification but sales suffer from a two-pronged handicap. Lack of a large electrical grid means that the stations will come in uneconomically small sizes and will operate at a low power factor; and underdeveloped countries, notoriously short of capital, can ill afford to invest in power equipment.

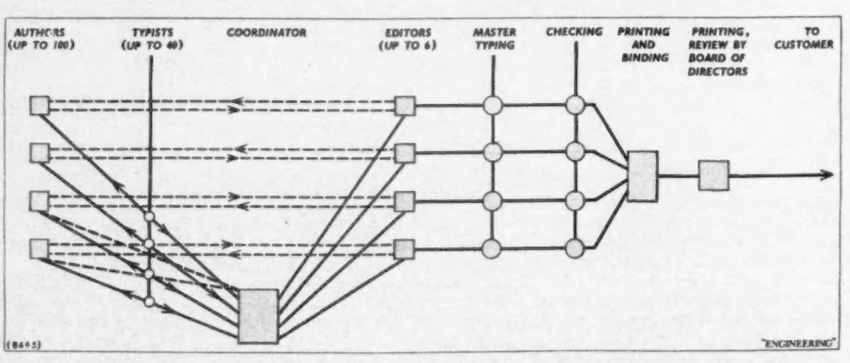
Lack of demand from abroad, and unrealised hopes at home have forced a progressive consolidation of the UK nuclear industry, reducing the number of consortia specialising in graphite-moderated reactors from a peak of five to the present three. Thus a virtual, although unintentional, monopoly on the demand side has been met by strength on the supply side. There is only one purchaser that counts, the Generating Board, and only three suppliers: the Nuclear Power Group, the English Electric—Babcock Wilcox—Taylor Woodrow consortium, and the Atomic Power Constructions—General Electric —Simon Carves complex. The situation is unlikely to change so long as graphite-moderated reactors are being bought by the Generating Board, because the art of tendering has grown over the years into something approaching an occult ritual open only to the initiated.

The purpose of the UK nuclear power programme is to build a series of reactor stations in order to gain experience, and thereby to reduce the construction costs. Intensive and often costly development is thus inherent in bidding for nuclear power stations, and the consortia are geared accordingly. The pressure towards advances in the design of a new station is reflected in the methods of tendering.

NINE MONTHS' GESTATION

The first official indication that the Generating Board has decided to purchase a nuclear power station for any particular site is the arrival of the inquiry specification. The document is in fact an invitation to tender extended to selected bidders, and leaves about nine months for the preparation of the tender documents. But in general the consortia are aware of the CEGB's intentions to build a particular station well before the arrival of the invitation, and about three months of preparatory work will have been completed in advance. Thus the preparation of tenders imposes a yearly cycle on the life of the consortia, with a corresponding wave of rising and declining activity progressing through the entire organisation.

The inquiry specification is a two-volume document. The first volume contains a detailed specification of the plant and all plant components; a second volume, called Schedules, lists all items to be supplied, leaving blank spaces for the prices and a description of technical details. The specifications are very similar for successive tenders, but between the Trawsfynydd and Dungeness contracts over 600 amendments were incorporated, making it impossible to submit the same design twice. Several further amendments were issued during the actual tendering period.



Ten thousand pages of manuscript follow this routing before a nuclear tender is completed.

Nine months after the receipt of the inquiry the finished tender is shipped to the Generating Board's offices. Each copy will comprise some 20 to 24 ring-binder volumes of tender documents, 10 to 20 volumes of schedules, 10 to 20 volumes of supporting reports, and some 10 volumes of civil engineering bills of quantities. Each tender is accompanied by 600 to 700 drawings of perhaps 42 in by 27 in size, enough to wallpaper ten average size rooms.

The magnitude of the task of producing a tender for the Generating Board is comparable to writing and publishing a 3,000 page technical book in a year under the strongest competitive pressure. The organisation to perform such a task varies from consortium to consortium, but in every case the company's entire resources are mobilised during the tendering period. One peculiarity of tender preparation is that as many as 20 sections will be written simultaneously, and the number of authors involved in the project may reach a hundred. Thus it is essential to have a master index prepared in advance, allocating detailed reference numbers to every plant component, drawing, or topic of discussion that will be found in the finished document in order to permit cross-references to sections or drawings that have not yet been prepared. The practice is similar to that found in other fields of tendering, but in the case of a nuclear power station contract there is an important difference in sheer size in addition to the fact that every station tendered is newly designed and unique.

The contract department has an important task in chasing the various authors and departments to produce their section in time for editing, correcting, typing, printing, collating and binding. The methods employed for editing again vary between the consortia. At one firm a panel of six editors, composed of the supply engineers of each section (mechanical, civil, control and so on) performs both the technical and the linguistic editing. At another firm the technical editing is done by the department heads, and a trained journalist with two assistants is employed to polish the writing.

The flow of documents through the departments of a typical firm is illustrated in the diagram. Long-hand drafts of the text are rough-typed and checked for technical accuracy and consistency with other sections. Several stages of editing and correction follow, making it more difficult to keep track of the manuscripts than would appear at first glance. During peak times 30 to 40 extra typists are employed, and recruitment can be a problem even in London.

Each consortium has its own printing plant. The facility is essential not only to improve the security arrangements for the tender, but also to ensure that external influences will not prevent completion of the tender in time. In a typical case the printing plant will operate with a normal staff of about 20 people, but during the final months of tendering this figure rises to 35 employees working regular overtime. Having a private printing plant on the premises enables the tendering company to make last-minute changes or improvements in the design. One firm claims that extensive rewriting is possible, provided the new master reaches the printer two hours before the tender is due to leave the office.

The appearance and presentation of the final document is considered important by some consortia. It is believed that although a perfectly presented tender may not add an iota to the company's chance of success, poor presentation will certainly tend to diminish it. Thus in one firm Vari-typers are used to give a printed appearance to the page; other firms use electric typewriters; and special ring-binders are produced with gold-lettering for the title. The complete tender of one firm is shipped in steel filing cabinets with a colour scheme matching the binders, two cabinets per copy of tender. In contrast, another consortium will leave little time for editing and fancy presentation, and will concentrate on producing the technically most up-to-date tender instead.

About 14 copies of the tender are prepared, six sets for the Generating Board, four for the United Kingdom Atomic Energy Authority who are the Board's consultants, and the rest for company use. But most consortia find it economical to print and store about 100 copies of each page for use only if the contract is won.

The cost of such a one-year exercise reaches into six figures. Counting only the direct cost of producing the tender, the lowest estimate produced by the groups is £100,000, the highest £400,000. These figures include the cost to the company of employing the design and clerical staff in connection with the tender only; the cost of computer-time; the cost of various licences (from the UKAEA or outside companies, through these fees are often payable only on successful tenders); and the cost of printing, binding and shipping the tenders. Not included in the figure are the cost of the tenders produced by subcontractors when bidding for components, or the cost of supporting research which each consortium is expected to undertake.

CHECK MATE

A great deal of experience is needed to produce a tender that will satisfy the highly refined taste of the Generating Board both in its technical content and in its presentation. Lack of experience in dealing with the Generating Board, and the high cost of producing a single tender, will make it very unlikely that any new firm or group will enter the tight reactor market during the present nuclear power programme. The " closed shop " aspect of the industry creates a very interesting balance of forces between the Generating Board and the suppliers.

There are three reactor makers bidding for one contract every year. The company that won the previous year's contract is naturally busy and in a weakened position in the current year, leaving only two serious contenders in the field. There is little to prevent the two firms from coming to some informal agreement to submit incomplete bids in alternate years. The firms stand to save over £100,000 and loose very little. But the Generating Board will loose heavily through lack of competition, and the aim of the nuclear programme will be frustrated. Just £1 more per kilowatt of net output (the price is nearly £100 per kW), and the Generating Board will be faced with a bill for £800,000 on the large stations that will be built in the 60's.

The paradox of the matter is that the Generating Board has to pay for abortive tenders in any case. The consortia are profit-making organisations and will be forced to include the cost of tendering in the price of future stations.

BONA FIDE INQUIRY

The situation with export tenders is rather different. As there is no market for small reactors in this country, it is convenient to discuss also the problem of the enriched-fuel reactor makers under this heading. Although the Ministry of Power have invited two rounds of tenders for a marine propulsion unit, securing eight tenders for the first round and five for the second, it is not at all certain that an order will materialise. On the other hand the Atomic Energy Authority have recently restated their continued lack of interest in small reactors, so that the enriched-fuel reactor makers must look for business abroad.

With almost every country hoping to establish a nuclear industry, there is keen interest in new developments. Quite often a government will announce ambitious plans for power station construction and hastily call for tenders, without first securing the necessary financial backing. A few years ago these inquiries were of a general nature, and could be answered with a brief, descriptive tender. But over the years the various governments have recruited a staff of experts and the inquiries grew and grew until today they approach the complexity of a Generating Board tender.

Only the need for commercial security keeps the length of foreign tenders within reasonable limits. There is always the danger that a foreign power company or government, on receipt of a large number of detailed tenders, will feel confident enough to build a station on its own, particularly if the tenderers themselves have never built a reactor before. A delicate compromise between revealing secrets and the need to sell the station must be reached. But this balance is generally upset by the customers' post-tender inquiries, which the hopeful bidders dare not leave unanswered. Thus any government can get an excellent education for its atomic energy authority by the simple expedient of calling for tenders, and asking enough questions. In the meantime the bidder bears the cost of tender preparation, and reveals commercial information for which he may have had to pay a considerable sum in royalties. It may be noted that the cost of tendering depends on the detail required, and is virtually independent of the station size.

The reactor companies, having submitted between six and ten abortive foreign tenders each, are now getting wise to the problem and carefully grade each inquiry. To accept an inquiry, the bidders must be assured that a suitable electrical load exists for the proposed station; that other forms of power generation are not significantly cheaper; and that the customer has lined up suitable financial backing. If any of the above conditions are missing, the tender submitted will be unoptimised, incomplete, or frankly outdated.

BENEFITS OF TENDERING

None of the reactor companies pretend that the cost of preparing a tender is wholly lost if no contract materialises. Particularly with the Generating Board tenders, where the loser stands a good chance on the next contract, the nuclear groups regard tendering as a form of annual examination. Through making a special effort every year, the company improves its competitive position both at home and abroad; the feverish last months of tendering show up weaknesses in the organisation; and the Generating Board's and Atomic Energy Authority's thoughtful analysis of the abortive tenders helps to eliminate undesirable design features. In addition continued tendering helps maintain the design staff intact and in good morale even though some of the tenders may be unsuccessful. The balance sheet is not nearly as favourable with foreign tenders where the analysis of rejected bids is less helpful.

Both the Generating Board and the nuclear consortia would benefit from some form of compensation for lost tenders, splitting the cost of preparation on a negotiated basis. The Generating Board are no doubt fully aware of the benefits of compensation, and the strength from which the industry is bargaining. It is significant that the Board have never replied with a definite " no " to the industry's exploratory moves, and that negotiations are still open. If an agreement is reached, it will probably be on an informal basis, and the danger that a bidder might find it more profitable to aim at getting the compensation instead of the contract will be assumed not to exist.

The export market for reactors is far more open and fluid, with the number of potential bidders increasing rather than decreasing. Under these conditions a company possessing or having built a reactor enjoys an overwhelming advantage. Such a company, offering a "turn-key " contract, need reveal very little important information and may point to its prototype as proof of the design instead of answering detailed questions. General Electric won the Italian SENN station with a single—though thick—volume of tender documents, backed up by its Vallecitos reactor. Some UK bidders on enriched reactors felt compelled to submit up to ten volumes of tender documents, and lost.

It is estimated that UK reactor companies have so far submitted over 30 abortive tenders other than for CEGB contracts, assessed at £100,000 each. For that much money two or three small prototype power-producing reactors could have been built (though not fuelled), one example of each major reactor type.

Precast Bridge Beams: Standard Sections

The Prestressed Concrete Development Group, in conjunction with the Ministry of Transport, have designed a range of standard precast beam sections for bridge spans of 25 to 55 feet. Only two sets of shuttering are required for the whole range of seven sections.

A very large proportion of the bridges in this country can be built using spans between 25 and 55 ft with a slab deck construction. To cut the cost of designing, tendering and making precast prestressed beams for such bridges, the Prestressed Concrete Development Group, in conjunction with the Ministry of Transport, have devised a range of standard sections for this work, to be used as inverted T-beams, filled with *in situ* concrete.

The range comprises two beam types, the smaller for spans between 25 and 35 ft and the larger for spans up to 55 ft, differing only in the depth of the web, as shown in Fig. 1. Altogether there are seven beams in the range, two of beam type 1 and five of type 2, the difference between the beams within a type being obtained by varying the depth of the top flange.

Thus only two sets of shuttering, one for each beam type, are required for the whole range, the varying top flange depths being obtained merely by screeding to different levels within the standard shutters. All seven beams are of the same overall width of 19½ in, so that three are needed for each 5 ft of bridge width (assuming ½ in joints between beams). The web thickness is also the same in every case, 4 in. Section properties are detailed in the table below. Either 0·2 in high tensile wire or 0·276 in diameter prestressing strand may be used (Fig. 2); generally the finer wire is to be preferred, though the use of strand in the longer spans reduces the congestion of the steel. Transverse holes, 2 in in diameter, are provided at 24 in centres, sufficient for transverse reinforcement of ½ sq. in per foot of span. These holes are sited in the fillet to the bottom flange and can be set at an angle to the axis of the beam to meet the requirements of skew bridges.

The stresses assumed in the design include the acceptance of tension in certain conditions. At transfer of the prestress, the concrete stress is to be 3,000 lb per sq. in or half the cube strength at transfer; 150 lb per sq. in is accepted in tension. Under working conditions the compression stress in the beams is to be one-third of the 28-day strength and there is to be no tension. For the *in situ* concrete, compression is not to exceed 2,000 lb per sq. in but tensile stresses of 675 lb per sq. in (abnormal loading) and 600 lb per sq. in (standard loading) are accepted.

All the beams are designed to withstand the load of the *in situ* concrete and construction traffic and to act monolithically with the *in situ* concrete to carry live loads. The live load is taken to be either the Ministry of Transport's abnormal or standard loading, the latter being identical for the spans concerned to the standard loading of BS 153 (part 3A) 1954.

Suggested arrangements of the beams are given in Fig. 3. It has been assumed for design purposes that the depth of *in situ* concrete above the tops of the beams will be at least 3 in and that there will also be a top wearing surface, and an allowance has been made for their weight by an additional uniformly distributed live load of 30 lb per sq. ft. For the bearings of the precast beams, it is recommended that they are seated on thicknesses of bituminised felt, rubber or neoprene.

In issuing details of the beam sections, the Development Group have prepared some notes describing the beams, giving details of the assumed stresses and also some worked examples for specific spans. Copies of these notes have already been distributed to members of the Group and by the Ministry to all local authorities. Additional copies can be obtained from the secretary of the Group at Terminal House, Grosvenor House, London, SW1. At the moment over 40 manufacturers of concrete products have agreed to make bridge beams that comply with suggestions put forward by the Group. It is also expected that certain contractors will carry suitable shuttering so that they can make the beams either at their works or on site.

The Group is now giving consideration to the standardisation of beams for longer spans.

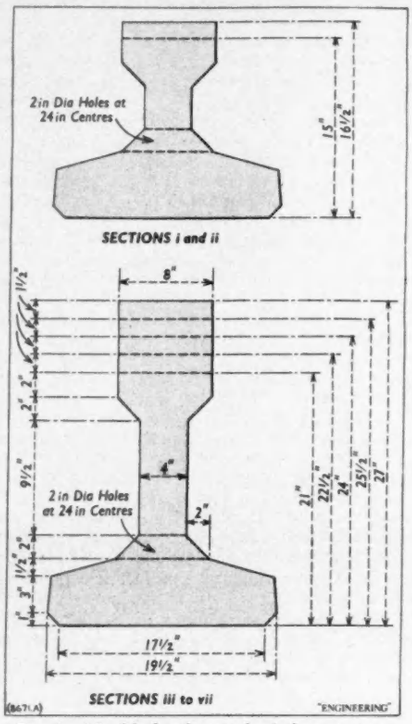


Fig. 1 Moulds for the two basic beam types.

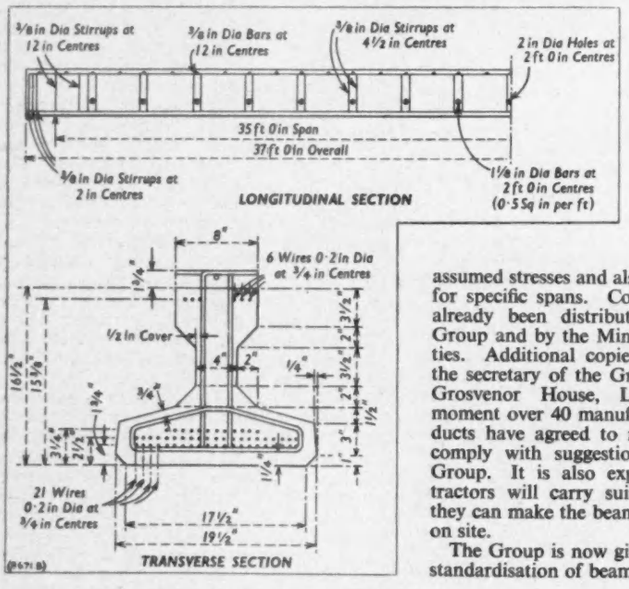

⅜in Dia Stirrups at 12 in Centres
⅜in Dia Bars at 12 in Centres
⅜in Dia Stirrups at 4½ in Centres
2 in Dia Holes at 2 ft 0 in Centres
35 ft 0 in Span
37 ft 0 in Overall
⅜in Dia Stirrups at 2 in Centres
LONGITUDINAL SECTION
1⅛in Dia Bars at 2 ft 0 in Centres (0·5 Sq in per ft)
8"
6 Wires 0·2 in Dia at ¾ in Centres
½ in Cover
16½"
15⅜"
21 Wires 0·2 in Dia at ¾ in Centres
17½"
19½"
TRANSVERSE SECTION
(B671.B)

Fig. 2 (left) Longitudinal and transverse sections of the beams, showing the location of the prestressing cables and reinforcement.

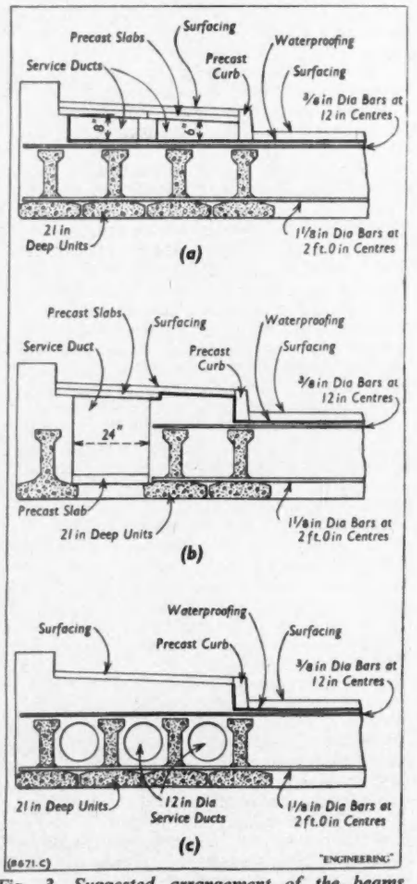


Fig. 3 Suggested arrangement of the beams within the deck slab.

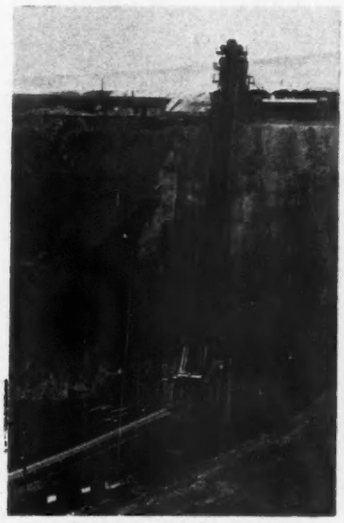
TABLE:—*Section Properties*

Standard beam type	Precast section number	Depth, in	Area, sq. in	Centre of gravity from top, in	Section moduli, in³		Self-weight, lb per ft
					Top fibre	Bottom fibre	
1	i	15	150·5	9·53	312	544	157
1	ii	16½	162·5	10·27	403	665	169
2	iii	21	174·5	13·40	565	1,002	182
2	iv	22½	186·5	14·00	703	1,158	194
2	v	24	198·5	14·60	843	1,310	207
2	vi	25½	210·5	15·22	983	1 458	219
2	vii	27	222·5	15·86	1,125	1,605	232

Belt Conveyor for Steep Gradients

An efficient high-angle belt conveyor system, for use in quarries and open-cast coal mines of exceptional depth, can provide considerable economies in working and lay-out costs. The main problem in conveying materials up steep gradients is the tendency of the load to slip, but this can be overcome.

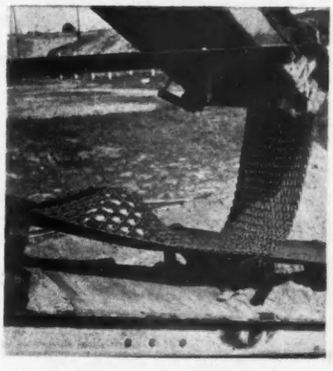
The basic principle is extremely simple. An endless belt of flexible chain matting is laid over the load on the conveyor belt to prevent the materials from rolling or slipping. The weight



High gradient conveyor in a quarry.

of the mat depends upon the nature of the material and on the conveying angle.

The endless chain-mat moves above the main conveyor belt at the same speed but is carried independently by a supporting belt driven from a single drum drive unit mounted on the loading frame. Material need not be sorted



A chain mat is used to hold the charge from slipping.

before being loaded on to the conveyor belt for the longitudinal and transverse flexibility and the crosswise expansibility of the chain mat allows even the largest material lumps to be covered and prevents the escape of adjacent material. A special steel covering can be used to protect the conveyor belt when iron ore and other sharp materials are being carried.

In addition to covering the material and increasing the friction between the material and the conveyor belt by its weight, the chain mat provides approximately 40 per cent of the total conveying effort.

When the conveyor belt is empty the chain mat simply lies on it and travels with it. The angle of the conveyor belt can be altered at will; furthermore, it has been found that incomplete loading and stopping have no effect upon the ability of the chain belt to hold the charge.

Richard Sutcliffe Limited hold the sole British manufacturing rights for the system.

Water Mains in Unplasticised Pvc

It is little more than a year ago that unplasticised pvc pipes for water mains were introduced in the United Kingdom by Yorkshire Imperial Metals Limited of Leeds. Last week, in London, before an audience drawn from water companies and local authorities, the company gave a demonstration of the latest jointing techniques used for their rigid Polyork B pipes.

Polyork B is a completey unplasticised pvc which is light in weight and almost totally inert, so that it is wholly resistant to corrosive action by salts in the grounds; the material is not attacked by termites. Its weight is typified by the fact that a 20 ft length of the pipe, suitable for a working head of 175 ft, weighs only 26 lb, against the 260 lb for a similar length of class B spun iron pipe. This lightness is reflected in the experience of one contractor who is reported to have been laying 1,200 yards a week of spun iron piping with a gang of twelve men; after conversion to pvc piping the laying rate doubled to 2,500 yards a week and the gang was halved to six men.

Construction is particularly simplified by the whip available in a long length of the pipe which means that jointing can be done above ground and the line then lowered into the trench. Fro this reason, too, the trench does not have to be wide enough to accommodate the men making joints, with a consequent reduction in excavation costs.

The piping is made as a continuous extrusion and then cut into standard lengths of 20 ft, though other lengths can readily be cut to order. It is available in nominal bore sizes from 2 in to 6 in (bores are in fact slightly larger than nominal) and in four classes, B1, B, C and D, corresponding to working heads of 150, 200, 300 and 400 ft. The very fine finish of the internal surface gives the pipes good flow characteristics, the value of C in the Hazen Williams formula varying from 110 for the smaller diameters to 140 for the 6 in bores. The natural light colour of the pvc is darkened by the addition of carbon so that all the pipes are of an opaque slate grey, which permits only the minimum absorption of ultra-violet light and possible tainting of the water. They are also virtually impermeable to gas. Bends are available in all sizes for angles of 90°, 45°, 22½° and 11¼°.

Two principal methods of jointing are recommended: the "O-R" shrink socket system and the "T-S" socket joint. For the former method, pipes are supplied with a socket heat-formed in the works on one end of each pipe. To make a joint, an O-ring is placed on the plain end of the pipe and this end inserted into the socket of the next pipe. The application of gentle heating by a blow-lamp is sufficient to make the socket shrink tight, compressing the O-ring and making a water-tight joint. A joint made in this way will not take much end load, so anchorage is advisable, and neither is it gas-tight.

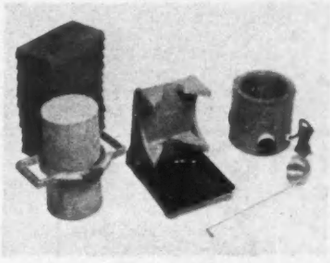
A stronger joint is obtained using a cold setting solvent cement to the adjacent ends as in the T-S method. For this method the pipes are supplied with one end as a socket and the other "taper-sized" to a mating male form. The surfaces to be joined are cleaned, roughened with emery cloth and a thin film of the solvent painted on with a brush. The joint is hard within five minutes, and the pipes usable in 20 minutes. Only a little easily learned skill is needed to make a good joint by heating though, because pvc is a very poor conductor of heat, care must be taken not to burn the material.

A whole range of mains ends connections and service connections, the latter in high impact pvc mouldings, are made for use with the.

Concrete Cylinder Capping Set

A cylinder capping set for preparing cylinaldric compression specimens of concrete has been designed for laboratories which have to handle only a small number of cylinders. It is made by Soiltest Incorporated of 4711 West North Avenue, Chicago 39, Illinois. The equipment is intended for use by contractors, testing laboratories, concrete plants, as well as by college laboratories.

The set, which is shown in the illustration, includes all items needed for capping 6 in by



Capping set for concrete cylinders.

12 in cylinders, including a vertical cylinder capper and capping plate; a 2 quart capping compound warmer; a capping ladle; and a cylinder carrier. Soiltest also supply capping compound in 50 lb packs.

The capping sets conform with ASTM test methods C-31 and C-192 and AASHO test procedures T-23 and T-126.

The same company have also produced a test apparatus for determining the bleeding rate and bleeding capacity of cement pastes and mortars. Intended only for research work, the apparatus gives continuous readings and the test conforms with the American Society of Testing Materials' procedure C-243.

Belt Loader Cuts Trenching Time

Both time and labour in cutting a trench five miles long for a gas main between Sheffield and Rotherham are being saved by the use of a

EL loader linked to trencher to cut spoil handling time.

portable belt loader. The contractors are William Press and Sons Limited of London, SW1. The arrangement of the equipment is shown in the illustration.

The trench is being dug by a Cleveland trencher which, until recently, was leaving the spoil at the side of the road to be loaded into lorries by an excavator or men with shovels. It was found that the tracks of the excavator were damaging the road surface and that loading by hand was both a long and expensive task. The remedy proved to be an EL loader, obtained from the Morley Hireplant Depot, coupled to the trencher so that the excavated material fell directly on to the conveyor and was then delivered into a lorry in front of the trencher.

Growing Acceptance of Air Conditioning

New styles in office building and the growth of precision industries are leading to a bright future for the makers of air conditioning equipment.

ONE of the forecasts most often heard in British manufacturing industry at the moment is that of a sweeping advance in the utilisation of air conditioning.

The reason given is usually one of three: first, the urgent necessity that every man on the factory floor and in the office shall be as productive and efficient as possible; secondly, the exacting demands of new industries such as the electronic industry where delicate operations need controlled air conditions.

By no means the least often heard, the third reason, is the sharpening of competition to provide packaged air conditioning equipment.

Such equipment could lead to a revolution in the use of air conditioning machinery in the United Kingdom because industry can now be offered a range of standard plant which, for obvious reasons, has advantages over the individually tailor-made installations.

Not only in the industrial and domestic building field has the need for air conditioning been proved and progressively applied, but in the transport field both on ships and on railways around the world, air conditioning is becoming an established amenity. The Midland Pullman train from Manchester to London is fully air conditioned. This is the first fully air conditioned train in the United Kingdom.

COMPETITION

Competition has been growing since the arrival on the scene of the Carrier Corporation of the United States, the largest makers of air conditioning and refrigeration equipment in the world. With the British group, Stone-Platt Industries, who have major interests in road, rail and ship refrigeration and air conditioning, Carrier Corporation towards the end of last year formed the Carlyle Air Conditioning and Refrigeration Company in London.

The opinions and beliefs of the air conditioning engineers from the United States, the home of advanced air conditioning development, are highly relevant to the way this industry is likely to progress in the United Kingdom.

Of the need for increased production from each man and machine there is no lack of evidence. The problem is where the effort is to come from. The shortage of skilled men has up to this moment been growing worse. That leaves the well recognised need for higher productivity. This is not only to be met by better training and more skilful incentives; it is also a question of conditions of work, and it is here that air conditioning comes in. It has been shown that controlling the temperature, humidity and flow of the air circulating in works or offices all the year round is not just a way of keeping the place cleaner, but improves efficiency to a measurable degree.

At a time when increased output from Britain's factories in order to reduce delays on deliveries is perhaps the most urgent single requirement, any supportable facts on doing a better job are worth study. The studies of air conditioning's effect on production carried out by the United States General Services Administration, a government agency responsible for the operations in 74 million sq. ft of industrial space, show what can be achieved.

The General Services Administration took for its experiments two large office spaces where in the course of the year thousands of clerical searches were conducted.

In every respect except one the two areas were identical as to lighting, paintwork, arrangement of equipment and number employed. In each area there were 70 people, alike as to ages and the numbers of men and women. But only one area was air conditioned.

After five months of work, in which exacting checks were made on rates of work, errors and absenteeism, the results were analysed. The output of work in the air conditioned office was 9 per cent greater.

The effect on absenteeism was also marked. The non-air conditioned area had 2½ per cent more absence than the air conditioned space. This was after all cases of absence due to causes in no way influenced by air conditions, accidents and so on, had been eliminated. This, of course, may be on the conservative side. There is not much doubt that one of the enthusiasts of air conditioning would claim that the person going home tired and stale after a day in unsatisfactory conditions of ventilation is more likely to become an accident victim than his opposite number leaving an air conditioned plant.

Skilled men are actively sought after in Britain. As the number of cleaner, more comfortable air conditioned works grows in the United Kingdom the ability to claim—"We are air conditioned, of course"—may have more than a little effect in attracting the right sort of man. This applies just as forcibly to office staff.

For office people, and to a rather less extent for factory workers, post-war architectural fashions have sharply heightened the desirability of air conditioning. A wide sheet of glass overlooking the Thames, or a London square, may be imposing and even impress the visitor, but for several months of the year it may be extremely unpleasant to work behind. On a by no means cloudless day the sun may easily raise the room temperature appreciably higher than outdoor shade temperatures. Under these conditions more attention is centred on rolling up sleeves and mopping the brow than on the affairs of the organisation that allows these conditions.

PARLIAMENTARY PIONEER

Around London and the provincial centres there is a planned volume of new office building, incorporating many millions of square feet of office space, all to be built in the next few years. So much of this space is to be behind large windows that the potential for air conditioning equipment is plainly substantial. Ever since 1836 when Dr. Reid attempted to introduce artificial humidification into the House of Commons the need for controlling air for human comfort has been recognised. Reid's method was to filter air through a veil 42 ft long and 18 ft 6 in deep and to introduce the air into the chamber through nearly a million holes in the floor.

A Bill may be presented before Parliament in the near future based on the Gowers Committee report which was presented to the Labour Government in 1949. The report called for sweeping changes which would revolutionise the working conditions of millions of city workers. Offices, for example, the report said, should have a high standard of fresh air ventilation, light and a minimum space of 400 cu. ft for every person employed.

Some factory operations produce conditions where a limited number of operatives, or even one man, require cooling down if, to put it no higher, the employee is to be kept happy.

The steel industry provides a good example. Air conditioning an entire steel works, or an iron foundry, would be something more than a standard assignment. But the man who has to stand in front of an open furnace door wants something done for him. The answer to this is air conditioning the particular worker—spot cooling. It amounts to directing a stream of cool air at the man on the hot spot.

The use of air conditioning in the unique American "dining-cars," railroad dining coaches bought and put straight down beside the highway to serve the passing traveller, showed its adaptability in a corner where money was tight.

With the filled places and busy cooking stoves of the first dining-cars came a threat that the whole idea would cancel itself out, because of the great heat inside the coach. Air conditioning engineers found that to circulate cooled air around the whole coach would cost considerably more in the installation of the equipment than the car had cost.

The answer, after much argument and wasted calculation, was the inspiration that now spot cools the blast furnace man. Cooled air was blown along the line of customers sitting up to the serving bar. The benefit to those sitting further away from the bar, and so further from the cooking stoves, was incidental, but it was enough to keep them happy. It was also enough to keep the coach caterer in business and for the roadside diner, now at great cost, with every possible refinement, to spread all over the United States.

ESSENTIAL TO ELECTRONICS

In Britain and the Commonwealth known and expected plans for new factories indicate the size of the expanding market for air conditioning equipment.

Electronics could scarcely exist without efficient air conditioning. Transistor production and the assembly of miniaturised equipment are functions in which air-borne dirt has to be reduced to a minimum.

Since computers need air conditioning, their expected enormous expansion into every kind of industrial application will serve as an introduction for air conditioning equipment in those parts of the world lagging in its application.

A glance at one of the key companies, Elliott-Automation, which has for some time been adding six new divisions a year to its organisation shows how fast is the growth of the electronics industry.

It may be possible to go too far in identifying certain fields of industry as the big growth possibilities for air conditioning. That was not how it worked in the United States. Air conditioning began there in 1902 when a young research engineer, the 25-year-old Willis Carrier, succeeded in finding a method of controlling the humidity in a lithograph printing plant in Brooklyn. The eventual installation which was carried out at the printing plant is recognised as the world's first scientific industrial air conditioning system because of the addition of humidity control to ventilation. Authorities in this field agree that air conditioning must perform four basic functions. It must—

1 Control temperature
2 Control humidity
3 Control air circulation and ventilation; and
4 Cleanse the air.

The time-scale of the American air conditioning development is something like this. From the first air conditioning plant by Dr. Willis Carrier, one of the five founders of the Carrier Corporation, up to the depression of 1929 the industry was moving through the first "educational" phase. The total sales graph was a slowly rising one.

Then, in the 1930's, came the "acceptance" period, which was interrupted by the Second World War, when the best new plants had air conditioning installed but the older works had to wait. Now the United States air conditioning industry has reached the "demand" period.

The anxious quest for greater production and profitability in the United Kingdom is a factor making for a shortening of the educational phases in this country.

The first experiences of the Carlyle company in London have been instructive. Inquiries from countries including Africa and Scandinavia have outpaced those from Britain.

Great Expectations

THE importance of economics in nuclear power must not be under-rated, since this factor, more than any other, is the trigger which will control the rate of commercial development in the nuclear field during the next few years. Much was said on this subject in Vienna at the International Atomic Energy Agency's conference on Small and Medium Power Reactors and several papers were devoted specifically to this aspect. From all that was said one is tempted to recall the tale that is told of the economics undergraduate who, on looking through the finals papers of the previous years, discovered that the questions were the same for each year. On mentioning this to his professor, the reply came "Ah! Yes, but we alter the answers each year."

Standardisation Required

The agency is doing much to try to standardise the method by which cost evaluations are made, as was shown in the paper presented by G. J. Petretic entitled "Nuclear Power Costs Evaluation." Many published fuel fabrication costs have no uniformity with regard to the items included in the estimate. Current estimates for the fabrication of zirconium and stainless steel clad uranium oxide fuels, and the magnox-clad natural uranium metal fuel are \$140, \$110 and \$15 per kilogram respectively. Using these costs, a 25 per cent thermal efficiency for small reactors, and a reasonable fuel performance, fabrication costs would be 2·1, 1·4, and 0·8 mills per kWh. These costs will be reduced as volume increases, technology improves and standardisation evolves. The processing cost of high burnup irradiated nuclear fuel may amount to 0·3 to 0·4 mills per kWh; these prices are based on Government regulations. A significant increase of up to 0·2 mills per kWh may be incurred for the small batches required for small reactors. Transport costs can also become a noticeable quantity for natural fuel of low burnup if the distance is great.

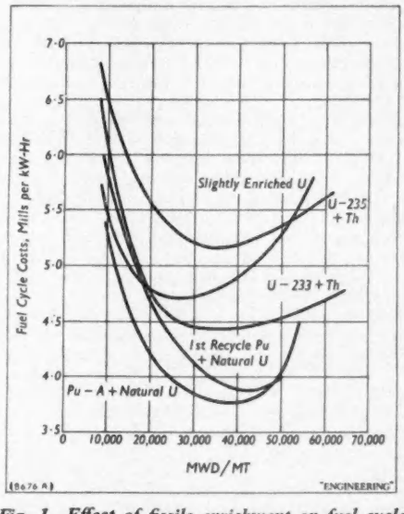


Fig. 1 Effect of fissile enrichment on fuel cycle costs for a uranium 235-plutonium-uranium 238 system.

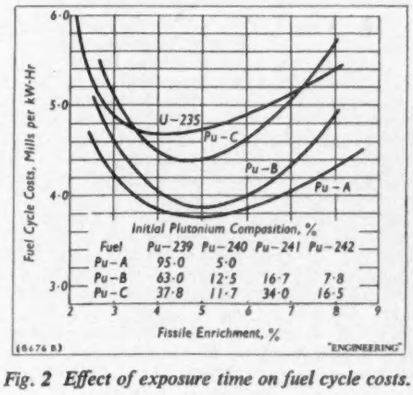


Fig. 2 Effect of exposure time on fuel cycle costs.

Enrichment and Burnup

An interesting paper by Mr. J. A. Lane entitled "The Possibilities of Reducing Power Costs in Small and Medium Nuclear Power Plants" indicates the possible trend that the costs will take. Fig. 1 shows the fuel cycle costs as a function of enrichment for a uranium 235, plutonium, uranium 238 system.

Minimum fuel costs occur at enrichments between 4 and 5 per cent and Pu-A and Pu-B result in total fuel costs of 3·8 and 3·9 mills per kWh respectively. These costs may be compared with the present day fuel costs based on a 2·5 per cent enrichment and 12,000 MWD per tonne burnup of 5·25 mills per kWh. Thus the use of a mixture of 95 per cent plutonium 239 plus 5 per cent plutonium 240, or the plutonium from the spent fuel of a slightly enriched loading in conjunction with natural uranium, does offer the possibility of reducing fuel costs.

Recycling Effect

Fig. 2 shows the results of fuel cost saving that can be expected by increasing the exposure time. Considering the above case, if the burnup is increased to 20,000 MWD per tonne, a fuel saving cost of 0·4 mills per kWh results. The use of recycle fuels would result in an additional saving from 0·1 to 0·6 mills per kWh. Burnups beyond 25,000 MWD per tonne offer no economic advantage with slightly enriched uranium fuel, and with recycle plutonium it is necessary to achieve about 40,000 MWD per tonne to obtain minimum fuel costs.

Generating Costs

In practice the uniform annual charge is determined in two steps. All expenditures are reduced to their equivalent values at the time of commissioning of the plant and these values added together. The same is done for all anticipated credits. The difference between the two sums is then spread uniformly over the life of the plant by a simple annuity computation. Variations in the generating costs for the same reactor design, arising from numerous uncertainties surrounding some of the initial cost figures, may be further compounded by the use of different methods to determine the unit generating costs. In the allocation of capital costs, for instance, it is very difficult to accurately judge the depreciation charges. Interest rates are associated with deep problems, and the possible reduction in fuel fabrication costs over the next decade, due to the comparative mass production that will arise with the increase in the number of reactors, all tend to make a true assessment very difficult.

Practical Experience Required

The IAEA paper shows how it is possible to arrive at figures varying up to 26 per cent, depending on which approach is used. The most satisfactory answer that can be given was indicated by Mr. E. Jones of the Hallam Project, who said that they were building the reactor to find out whether or not it would be economic. Until more reactors of all sizes are built and operated from a commercial standpoint, it will not be possible to make a true estimate.

Transition Phase

Encouragement may be taken from the remarks of Mr. Ulysses M. Staebler, of the United States Atomic Energy Commission, who presented a review of the overall status and future plans of the United States power reactor programme. He emphasised the broad technical base of the programme in which a variety of reactor concepts are

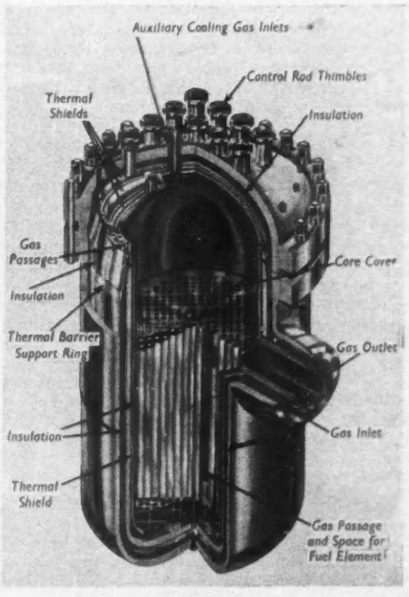


Fig. 3 Cutaway view of the high temperature, helium gas-cooled beryllium-oxide moderated reactor of General Dynamics Corporation's MGCR nuclear power system.

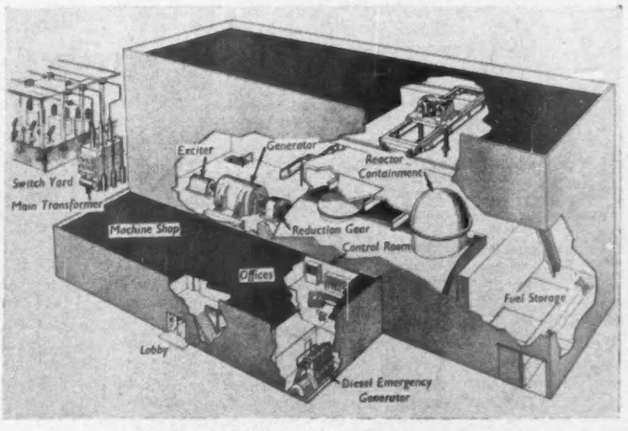


Fig. 4 A schematic view of the General Dynamics MGCR nuclear power system as applied to a small central station plant. The compact system may be directly coupled to a high temperature helium gas-cooled reactor with a closed-cycle gas-turbine.

being developed through laboratory experiments, theoretical analysis, and experimental operation of a variety of facilities. He stated that "the present status of nuclear power development may be described as a transition phase wherein some reactor concepts appear to be economically justified, or nearly so, in special situations. Thus a transition toward a normal commercial industry activated by economic incentives is well along."

Maritime Gas-Cooled Reactor

Mr. Titus G. LeClair, manager of nuclear power applications for General Atomic, a division of General Dynamics Corporation, discussed applications for small, land-based power generation of the Maritime Gas-Cooled Reactor (MGCR) which General Dynamics is developing for the US Atomic Energy Commission and Maritime Administration. His paper was titled: "MGCR as a Small Central Station Power Plant." He said the MGCR, in addition to its advantages for merchant ship propulsion, is uniquely suited to central station operation where limited amounts of reliable, low-cost nuclear power are required. The MGCR was described by LeClair as a compact, high performance system that directly couples to a high-temperature helium-gas-cooled nuclear reactor with a closed-cycle gas turbine and is thus able to operate at peak efficiency over a wide range of power settings, from 10 per cent to full power. The MGCR is moderated with beryllium oxide, affording high neutron economy and resultant lowering of fuel costs. The fuel is heterogeneously distributed through the reactor core in metal-clad ceramic fuel bodies containing uranium oxide, Fig. 3 gives a sectioned view of the core.

Not Scaled-Down Large Plants

Mr. LeClair pointed out that small power plants, instead of being merely scaled-down versions of large plants, must be especially designed for low load factors because of fluctuating power demands. This means that the plant must have a power cycle that insures flexibility without sacrifice of efficiency. Thus simplicity, reliability and automation are particularly important factors in the small plant because it cannot afford extensive maintenance facilities or large operating crew. "The MGCR is the only gas-cooled reactor presently under development which has the objective of meeting these small plant requirements for the production of low-cost power," he stated.

MGCR Advantages

He added that the MGCR possesses a large potential for further development in terms of high temperatures and lower capital costs without increasing the plant's size. He cited the following among the MGCR's advantages for reliable, flexible and economic small plant operation.

(1) High thermodynamic efficiency through high temperature operation, with helium outlet temperatures of from 1,300° F (705° C) to 1,500° F (815° C).

(2) Long fuel life with resultant low operating costs.

(3) Low capital cost due to the plant's simplicity and use of the closed-cycle gas turbine.

(4) Ease of maintenance and high degree of automation.

(5) Compactness and minimum weight.

(6) Flexibility of efficient operation over a wide power range.

(7) Versatility of applications.

(8) Safety and reliability.

Power Cost for MGCR

In discussing the economic promise of the MGCR, LeClair said a 23 MW plant, which would be the first plant of this design, could be expected to produce power at an overall cost of 14·4 mills per kilowatt hour, assuming an 80 per cent load factor and capital charges of 14 per cent. With an increase in the reactor's outlet temperature to 1,500° F and some increase in plant size the power cost could be sharply reduced.

HTGC Reactors of 40 and 100 MW

Dr. F. de Hoffmann, senior vice-president of General Dynamics and president of its General Atomic Division, reported on "The Application of High Temperature Gas Cooling to Nuclear Power Plants," including design information and operating data on the 40 MW High-Temperature Gas-Cooled Reactor (HTGR) plant to be completed in 1963 on the system of the Philadelphia Electric Company. Dr. de Hoffmann also is president of General Atomic Europe, with initial offices at Weinbergstrasse 109, Zurich, Switzerland. The technical staff of the new European-wide company is engaged in developing an HTGCR system in the 100 MW range specifically suited to the requirements of European electric power generating systems.

Homogeneous Fuel-Moderator

He described the HTGR's solid homogeneous fuel-moderator elements, clad in graphite, which make possible the production of steam at modern steam-turbine conditions, high power density, high fuel burnup, simplicity, compactness and a high degree of inherent safety. "This class of reactor not only appears to have the best chance of achieving really economic large-scale nuclear power production, but the field for its further development seems relatively unrestricted."

Reprocessing No Longer Critical

Dr. de Hoffmann, in his report on the application of high-temperature gas cooling to nuclear power plants, said that the General Dynamics HTGR meets the requirement for sufficient heat extraction from the nuclear core to reduce the need for fuel re-cycling "to the point where reprocessing no longer dominates the fuel costs and, indeed, may be dispensed with at very little penalty." He said that the HTGR's graphite-clad fuel elements provide a high fuel burnup for each core loading because of the high dilution of the uranium 235 fuel and fertile thorium 232 by the graphite moderator, and because of the small ratio of parasitic absorbers involved in the reactor's core structure. The long reactivity associated with the HTGR's uranium-thorium fuel cycle permits a core lifetime of about three years for a 40 MW plant, and up to as long as five to seven years for large plants.

Advantages of HTGR

The major advantages of the HTGR included the following:—

(1) Production of steam at 1,000° F (538° C) and 1,450 lb per sq. in to conform to modern steam-turbine conditions, through use of novel homoegeneous fuel-moderator elements clad in graphite which, together with helium gas cooling, makes possible a coolant outlet temperature of 1,380° F (749° C) and a thermal efficiency of about 40 per cent.

(2) High power density, resulting from the high surface temperature of the graphite-clad homogeneous fuel elements which affords excellent heat transfer to the coolant. A very large cooling surface can be packed into a relatively small core size.

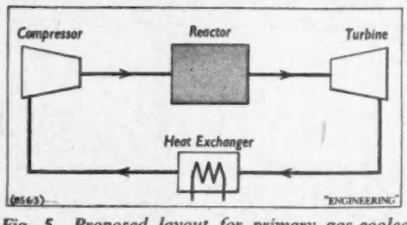


Fig. 5 Proposed layout for primary gas-cooled circuit.

(3) Low capital costs resulting from a simple, compact, high-temperature system. Gas cooling permits operation at high temperatures with pressures of only 300 lb per sq. in. These low pressures, together with the low stored energy characteristic of gas coolants, eliminates the need for heavy pressure vessels and containment structures.

(4) High fuel burnup, leading to lowered operating costs.

(5) A high degree of inherent safety, as result of the homogeneous fuel elements' large heat capacity to protect the reactor core in event of any sudden power rises or changes in coolant flow.

Costs for Large HTGR Reactors

Dr. de Hoffmann's estimates for a medium size, 100 MW HTGR plant—extrapolated from General Atomic's design studies of plants of 150 and 300 MW—indicated that fuel costs should be relatively low, probably in the range of 2·5 to 3 mills per kilowatt hour for such smaller plants, including interest, uranium use charges and reprocessing. The capital costs for a 100 MW plant were estimated to be from $250 to $300 per kilowatt, or 5 to 6 mills per kilowatt hour. With operating and maintenance costs, an expected overall power cost of from 8·5 to 10 mills per kilowatt hour was shown. "If we are able to achieve the lower of these estimates," he said, "then HTGR plants in the 100 MW size certainly would be competitive with many conventional power stations in this size."

High Temperature Loop

In a report published by Dr. P. Fortescue on "Free Running Turbo-Circulators for Gas-Cooled Reactors" (AERE—ED/R2486) in September '56 (also see ENGNG., vol. 185, 1958, p. 284) the results are given of an inquiry into the possible applications of gas turbine techniques to the problem of power production from gas-cooled reactors. The scheme proposed is shown diagrammatically in Fig. 5. It consists of a primary gas-coolant circuit, in which circulation is achieved by a totally enclosed and self-operating compressor-turbine system having no external shaft and thus no seal problem. Heat is rejected through a heat exchanger to a secondary system which could be either an open or closed circuit gas turbine, or a steam cycle, depending on the temperature range contemplated. The whole of the reactor heat production is passed to the secondary circuit, but there will be a loss in this heat for ultimate power production because of the necessary drop in temperature across the turbine. The ultimate success of the scheme is governed by how much the heat is degraded to provide sufficient power for the pumping power losses demanded by the reactor and its primary circuit. A patent taken out by Esso Research and Engineering Company, USA, in August, 1958, proposes a similar scheme; it suggests a working fluid of helium containing uranium hexafluoride. A paper read at the symposium on gas-cooled reactors sponsored by the Franklin Institute and the American Nuclear Society in Feb. '60 described a closed-cycle gas turbine operating in a direct cycle with the reactor. The plant is designed to produce 22,600 b.h.p. operating on a regenerative, intercooled cycle, again using helium for the working gas. The initial design points are for a maximum cycle temperature in the 1,300° to 1,500° F range, with normal continuous operation at 1,300° F.

Monitoring Helium Impurities

A katharometer has been developed at AERE, Harwell, intended particularly for the analysis of helium blanket gas in reactors such as DIDO and PLUTO. But the equipment might be useful in measuring the total impurities (less hydrogen) of helium coolant in the HTGC reactor—if the activity is not too high. Two designs of katharometer were tried. They had base line drifts low enough for use in a continuous analyser, their sensitivities being 1,000 ppm and 5,000 ppm for full-scale deflection. Sensitivity of the detector to hydrogen and deuterium is such that for concentrations of the gases equal to the sum of the other impurities, corrections are less than 3 per cent and 11 per cent respectively. (AERE C/R 2808, *The Measurement of Impurities in Helium. Part 1, the Katharometer as a Continuous Analyser for Total Impurities*, M. Wilkins, and J. D Wilson, 14 pages, 7 figures, 3*s* 6*d*.)

The

'Engineering' Appointments

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The increasing application of Work Study techniques to technical problems enables Imperial Chemical Industries Limited to offer positions to graduate chemical and mechanical engineers. These men should possess good engineering qualifications and should not be over 30 years of age. They will be selected with a view to their potential for moving to senior jobs in the Company. They will initially receive a thorough training in the principles of Work Study techniques. At the end of this time, it is envisaged that they will continue their careers in the field of technical management in one of the Company's manufacturing divisions.

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Vacancies exist on the Permanent Staff for CIVIL ENGINEERS for service in the Chief Engineer's Department of the Rhodesia Railways. Normally applicants under 30 years of age will be given preference.

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£1000 by £100 to £1200
£1200 by £50 to £1500
£1500 by £100 to £1800.

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RHODESIA RAILWAYS,
241, SALISBURY HOUSE,
LONDON WALL, LONDON, E.C.2,

from whom full details regarding conditions of service may be obtained.

C 999

ADVANCED SCHOOL OF AUTOMOBILE ENGINEERING CRANFIELD

Applications are invited for appointment as

SENIOR LECTURER
or
LECTURER

for teaching at post-graduate level in the application of science and technology to automobile engineering.

Candidates should be mechanical engineers with experience in heat engines and should have an honours degree. Experience in the automobile industry will be an advantage.

Every encouragement given to personal research.

Salary scales under review; at present:
SENIOR LECTURER, £1700 by £75 to £2150 p.a.
LECTURER, £900 by £50 to £1350 by £75 to £1650 p.a.
with superannuation under F.S.S.U. and family allowance.

Further particulars available from the Recorder,

THE
COLLEGE OF AERONAUTICS
CRANFIELD · BLETCHLEY
BUCKS.

C 993

THE SCIENTIFIC CIVIL SERVICE

needs men and women for pensionable posts as (*a*) SENIOR SCIENTIFIC OFFICERS and (*b*) SCIENTIFIC OFFICERS in all major scientific fields, including

PHYSICS
ENGINEERING
CHEMISTRY
METEOROLOGY
MATHEMATICS and
BIOLOGICAL SUBJECTS

Age limits: (*a*) at least 26 and under 32, (*b*) at least 21 and under 29. Extension for regular Forces service and Overseas Civil Service. Qualifications: normally first or second class honours degree in science, mathematics or engineering, or equivalent attainment; additionally for (*a*), at least 3 years' relevant (*e.g.*, post-graduate) experience. Selection by interview. London salaries (men): (*a*) £1330-£1640, (*b*) £730-£1205; provision for starting pay above minimum. Promotion prospects.—Write CIVIL SERVICE COMMISSION, 17, NORTH AUDLEY STREET, LONDON, W.1, for application form, quoting (*a*) 8/53/60, (*b*) 8/52/60.

D 10

RESEARCH and **DEVELOPMENT DEPARTMENT**
Applications Branch

LARGE SCALE EXPERIMENTAL RIGS

ENGINEERS and DRAUGHTSMEN

required for a team being built up to carry out the design of large-scale experimental rigs. The team will be located at Guildford and, working in close collaboration with the Board's Laboratories, will be responsible for the complete design of large experimental rigs and items of experimental plant and equipment to outline requirements given by the Laboratories.

The type of work to be carried out covers the wide range of Power Systems and includes High Temperature and Pressure Steam, Combustion Equipment, Heat Exchanger Equipment, Fuel Handling, Automatic Control Systems, Electrical Equipment, including plant for D.C. Transmission and Direct Generation, and experimental switchgear.

This interesting and unusual work offers a challenge to Engineers with initiative who, using to the full their engineering resources and inventive ability, are able to work with the minimum of supervision.

Applications are invited for the following positions in the team:—

(A) TEAM LEADER

Candidates should hold a degree, preferably in mechanical engineering, and some electrical knowledge is also necessary. They must have considerable experience in the design of large mechanical or chemical projects and have broad, rather than specialised, engineering interests.

(B) MECHANICAL AND ELECTRICAL ENGINEERS

Candidates should preferably hold a degree, but applications will be considered from men possessing H.N.C. or equivalent with the relevant experience. **Senior and Junior Engineers** are required and for the senior posts design experience in one or more of the above-mentioned fields is essential.

(C) DESIGN DRAUGHTSMEN

Candidates should possess H.N.C. or O.N.C. and have several years' drawing office experience. The work will provide every opportunity for Draughtsmen to use their qualities of versatility and ingenuity.

● ***Commencing salaries according to duties and responsibilities will be; Post (a) within the range £1,745-£2,395 p.a. Post (b) on the scales within the range £1,115-£2,085 p.a. or £625-£1,325 p.a. Post (c) on scales within the range £715-£1,245 p.a.***

Successful candidates can be assured of excellent career prospects and of being engaged on forward-looking work. Staff are given every facility to publish technical and scientific papers.

Assistance may, under certain conditions, be given towards house purchase.

Applications, stating age, qualifications, experience, present position and salary and indicating post applied for, to the Personnel Officer, 24-30, Holborn, London, E.C.1, as soon as possible, Envelopes should be marked "Confidential. Ref. ENG/342."

Central Electricity Generating Board

C 991

BRITISH IRON AND STEEL FEDERATION

Applications are invited for the post of HEAD OF THE TRANSLATIONS SECTION of the Intelligence Department.

Applicants (male, British nationality) should have fluent French and German, and a third language—Russian or Spanish—would be an advantage; overseas experience in the appropriate countries in a most desirable qualification. Some experience of the steel producing or consuming industries would also be an advantage.

The post is a senior one and a salary in line with the responsibilities involved will be paid. Applications should be made in writing, and should be addressed to:

The Finance and Establishment Department (T.10),
British Iron and Steel Federation,
Steel House,
Tothill Street,
London, S.W.1.

C 984

ENGINEER (TECHNICAL WORKS)

MINISTRY OF HEALTH. Pensionable post in London for man at least 30 on September 1, 1960, for duties concerned with pricing and cost analysis of mechanical and electrical engineering services in buildings. Qualifications: apprenticeship and good experience in mechanical/electrical installation and maintenance work; technical qualifications of H.N.C. standard normally expected. Applicants must be familiar with contract conditions. Salary scale £1375-£1589.—Write CIVIL SERVICE COMMISSION, 17 NORTH AUDLEY STREET, LONDON, W.1, for application form, quoting 8/5199/60. Closing date 20th October, 1960. D 9

SOUTH AFRICAN COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH NATIONAL INSTITUTE FOR ROAD RESEARCH

VACANCY:

CIVIL ENGINEER

Applications are invited from graduates in Civil Engineering, with several years practical experience of road construction and maintenance, for the post of Research Officer in the Soil Mechanics Division of the National Institute for Road Research, Pretoria, South Africa.

Research is to be done into the construction and maintenance of gravel roads with the object of reducing costs and alleviating the dust nuisance. The project is to be started by a thorough examination on full-scale road trials of the use of waste sulphite liquor from the pulp industry.

The salary will be according to qualifications and experience on one of the following scales:—

Senior Research Officer: £1380 by £60 to £1740 by £60 to £1860.

Research Officer: £1080 by £60 to £1320 by £60 to £1560.

The Council will bear the cost of transfer of the successful applicant and his family from place of residence to Pretoria and will contribute to the cost of transport of household effects. A certificate of good health and a chest X-ray examination will be required.

Information regarding general conditions of service may be obtained from the South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2.

Formal applications for the post giving full details of age, marital status, nationality, scientific and technical qualifications and experience, and the names of at least two persons to whom reference may be made, should be submitted, in the first instance to the SOUTH AFRICAN SCIENTIFIC LIAISON OFFICER, LONDON. C 981

CIVIL, STRUCTURAL, AND PUBLIC HEALTH ENGINEERS

Pensionable posts for men and women at least 25 and under 35 on January 1, 1960 (extension for regular Forces service, Overseas Civil Service, established civil service and temporary Government service as Civil, Structural, or Public Health Engineer). Candidates must have achieved Corporate membership of an appropriate professional Institution or have passed examinations necessary for attaining such membership. Salary (men, London), £830-£1125 according to age, rising to £1300. Promotion prospects.—Write CIVIL SERVICE COMMISSION, 17 NORTH AUDLEY STREET, LONDON, W.1, for application form quoting, S/64-66. D 11

DEVELOPMENT ENGINEER

age 25-30 years with H.N.C. or degree, with wide experience and willingness to tackle a variety of problems, required for investigations in the department cutting up, inspecting and packing photographic paper.

Salary up to £1100 p.a., according to age, qualifications and experience.

This vacancy is at the Harrow Factory of Kodak Limited where over half of the 10,000 people in the organization are employed.

Free sickness scheme and voluntary part contributory life insurance. Pension plans in operation.

Write for application form to:

THE PERSONNEL MANAGER,
KODAK LIMITED (FACTORIES),
WEALDSTONE, HARROW, MIDDLESEX

D 15

THE SCIENTIFIC CIVIL SERVICE

needs men and women for pensionable posts as ASSISTANTS (SCIENTIFIC). Ages at least 17½ and normally under 26 on 1.1.60 with appropriate educational or technical qualifications (normally G.C.E. with passes at O or A level in 4 distinct subjects including English language and a scientific or mathematical subject, or O.N.C., or equivalent qualifications) and at least 2 years' experience in either: (i) engineering or physical sciences, or (ii) chemistry, bio-chemistry or metallurgy, or (iii) biological sciences, or (iv) geology, meteorology, or skilled work in laboratory crafts, such as glass-blowing. Starting salary (men, London) from £347 10s. (at 17½) to £550 (at 25 or over). Maximum (London) £715. Promotion prospects. Five-day week generally.—Write CIVIL SERVICE COMMISSION, 17 NORTH AUDLEY STREET, LONDON, W.1, for application form, quoting S/59/60. D 12

LONDON COUNTY COUNCIL WANDSWORTH TECHNICAL COLLEGE

Required as soon as possible owing to expansion of work:—

FOUR LECTURERS to teach:—

(i) and (ii) to H.N.C. Electrical Engineering standard. Experience in electrical power or measurements or Electronics and Transistors, an advantage.

(iii) Metallurgy to H.N.C. and degree standard.

(iv) Physics and Applied Physics to H.N.C. Metallurgy and Engineering level.

ONE ASSISTANT GRADE A to teach Mathematics to O.N.C. standard.

For all posts, graduate or equivalent qualifications required. Industrial and teaching experience desirable. Burnham F.E. salary scales: Lecturer, £1370 by £35 to £1550 plus London allowance. Possible entry above minimum of scale. Assistant Grade A, £520 by £27 10s. to £1000 plus London allowance and additions for qualifications and training. Increments within scale for approved experience.

Application forms from SECRETARY AT COLLEGE, WANDSWORTH HIGH STREET, S.W.18, to be returned by 7th October. Please quote (FE3a/En/2363/9). C 983

BRISTOL COLLEGE OF SCIENCE AND TECHNOLOGY

(A COLLEGE OF ADVANCED TECHNOLOGY)

ASHLEY DOWN, BRISTOL, 7.

PRINCIPAL: G. H. MOORE, M.Sc., F.P.S., F.R.I.C.

The Governors invite applications for the posts of LECTURERS (2) to teach heavy current subjects in courses leading to Dip. Tech. I.E.E. Part III, Higher National Diploma and Higher National Certificate. Candidates must hold appropriate academic and/or professional qualification and should have had teaching, industrial and/or research experience.

Salary within the range £1370 to £1550.

Application forms, returnable within two weeks, and details from the Registrar. D 8

ASSISTANT KEEPERS SCIENCE MUSEUM

Four pensionable posts for men or women at least 21 on 1.9.60. One in Department of Chemistry (to be in charge of Photographic Collection), 1 in Department of Astronomy and Geophysics (to be concerned with Meteorology, Navigation or Astronomy), and 2 in Department of Aeronautics and Sailing Ships (one to be in charge of Aeronautical Collection (engines and rockets) and the other to deal initially with Agricultural Machinery and Illumination Collections). Qualifications: 1st or 2nd class honours degree in Chemistry, Engineering, Physics or Mathematics (as appropriate), or equivalent, and preferably some post-graduate experience. Knowledge of foreign languages an advantage. Men's salary scales (London) £730-£1028 or £1310-£2190 according to age, qualifications and experience. Appointment on higher scale will not normally be before age 30 (or 28 for well qualified candidates). Starting pay may be above minimum on both scales. Promotion prospects.—Write CIVIL SERVICE COMMISSION, 17 NORTH AUDLEY STREET, LONDON W.1, for application form quoting S/5204/60. Closing date 3rd November, 1960. D 13

ESSEX TECHNICAL COMMITTEE

THURROCK TECHNICAL COLLEGE

WOODVIEW, GRAYS, ESSEX.

Applications are invited for the following post:—

ASSISTANT LECTURER GRADE B in the Engineering Department to teach Mathematics, Engineering Science, Machine Drawing and Physics up to Ordinary National Certificate standard and final City and Guilds Certificate standard.

Applicants should have good academic qualifications together with some industrial experience. Teaching experience would be an advantage.

Salary within scale £700 to £1150 per annum, plus additions for training and graduate qualifications if in accordance with Burnham Further Education Report conditions. The commencing salary will have regard to previous experience.

Application forms (to be returned as soon as possible) may be obtained from the COLLEGE CLERK. D 23

ENGINEERS, PHYSICISTS OR METALLURGISTS

PLASTICITY research at National Engineering Laboratory (D.S.I.R.), East Kilbride, Glasgow. Engineers, Physicists or Metallurgists required as SCIENTIFIC OFFICERS/SENIOR S.O.'s., to work on:—(*a*) existing formation processes for metals, *e.g.*, extrusion, forging and rolling, and new methods of producing plastic deformation, *e.g.*, explosive forming. (*b*) Plasticity including deformation and fracture, stress wave propagation in materials. (*c*) Mechanical and physical properties of materials under high fluid pressures, metal forming processes under such pressures, and production of materials by applying ultra high pressures and temperatures. Also a vacancy for a mathematician. (*d*) Theoretical plasticity including development of fundamental theory and solution of specific problems. Qualifications: 1st or 2nd Class Honours degree in appropriate scientific subject and (for S.S.O.) at least 3 years' post-graduate experience. Houses available for married staff in the New Town. Salary ranges:—(Men), S.O., £690-£1144. S.S.O., £1250-£1540. Forms from MINISTRY OF LABOUR, TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1. Quoting C.596/OA. Closing date, 24th OCTOBER, 1960. D 18

EXPERIMENTAL OFFICER

TROPICAL PRODUCTS INSTITUTE (D.S.I.R.), LONDON, W.C.1, requires EXPERIMENTAL OFFICER or A.E.O. for design and development work on small mechanisms, laboratory equipment and pilot plant. Should have workshop background with electrical experience. Qualifications: H.N.C. Elec. or Mech. Engineering or equivalent generally expected. Salary ranges:—(Men), A.E.O., £447 10s. (age 18)-£970. E.O. (minimum age 26), £1075-£1325. Forms from MINISTRY OF LABOUR, TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1, quoting D.602/OA. Closing date, 14th OCTOBER, 1960. D 17

SCIENTIFIC OFFICERS

MACHINE TOOL RESEARCH at National Engineering Laboratory (D.S.I.R.), East Kilbride, Glasgow. Scientific Officers/Senior S.O.'s required in new team being formed to cover all aspects of machine tool control. Scope for research in new methods as well as improvements in existing methods.

POST A. Measuring Systems: Electrical Engineer with practical experience in electrical measurement of mechanical quantities.

POST B. Servo-systems: Electrical or mechanical engineer with theoretical and practical post-graduate experience of servo-systems; scope for comparing theory and practice in applications from precision instruments to machine tools.

POST C. Mathematical Control: Mathematician, preferably with experience in application of mathematics to engineering problems, of digital computers and of numerical analysis, to survey existing methods of instructing machine tools to carry out machining operations, and develop new methods in conjunction with engineers.

POST D. Electronic Systems: Electrical engineer with practical experience of electronic circuits, knowledge of pulse techniques, digital counting and recording, and transistor circuits, to design new circuits to measure and inspect mechanical parts, and develop electro/mechanical and electro/hydraulic servo controls.

POST E. Hydraulic servo-components: Mechanical engineer with experience in design and use of control valves and servo motors to evaluate performance of existing components and originate new ones. Qualifications: 1st or 2nd Class Honours degree in appropriate subject and (for S.S.O.) at least 3 years' post-graduate experience. Houses available for married staff in New Town. Salary ranges: (Men), S.O., £690-£1144. S.S.O., £1250-£1540. Forms from MINISTRY OF LABOUR, TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1, quoting D.614/OA and post in which interested. Closing date, 17 OCTOBER, 1960. D 19

APPOINTMENTS OPEN

SENIOR ENGINEER

Wanted by Paper Mill near Dublin, SENIOR ENGINEER, with at least 20 years' experience of maintenance of heavy plant and installation of new plant on an extensive scale. University Graduate or Member of Institution of Mechanical Engineering preferred. Good salary offered to proved competent hard worker. Apply to BOX C957, Offices of ENGINEERING.

PILKINGTONS

the greatest name in the world of GLASS

have vacancies NOW in the largest and best equipped glass research unit in the world.

Fundamental and applied research and pilot plant work on a scale larger than usual is being carried out in the following fields:—

Solid state physics
Reaction kinetics
Heat transfer
Thermodynamics
X-ray techniques
Electronics

covering the range of products from sheet, plate and Float glass to cathode ray tubes, high voltage insulators and Fibreglass.

Graduates interested in this type of industrial research work are invited to write to

Mr. W. J. R. Merren,
Director of Research
Pilkington Brothers Limited
St. Helens · Lancashire

C 982

SCIENTIFIC and TECHNICAL ADVANCES IN THE GAS INDUSTRY

provide opportunities for qualified staff to undertake interesting and progressive work in the Central Laboratories of the South Eastern Gas Board.

Vacancies exist for:—

Scientific Staff

Applicants for these vacancies should be qualified Chemists or Physicists prepared to deal with practical problems associated with the manufacture and utilisation of town gas and its products.

Technicians

Applicants for these vacancies should be competent craftsmen who have studied and obtained qualifications in their craft and are willing to gain experience to enable them to become specialists in various branches of gas and fuel technology.

Junior Staff

The Board needs young men and women with an educational standard of at least "O" level G.C.E. in several subjects including science, who are prepared to study for further qualifications while undergoing practical training in the laboratories.

Good starting salaries
Good prospects
Good Pension Scheme

Apply in writing, giving age, full details of education, qualifications, etc., and quoting reference V15/1322, to

The Personnel Manager,
SOUTH EASTERN GAS BOARD,
Katharine Street, Croydon

D 6

CHIEF ENGINEER

for the main mill of Star Paper Mills Ltd., Feniscowles, North Lancashire. The Company, situated in very attractive surroundings, operate two modern paper-making machines and considerable ancillary equipment, including after-coating machinery. The plant is managed by up-to-date practices. Commencing salary will be commensurate with responsibilities of the appointment and will be progressive. Other benefits include a generous pension scheme and a car. Conveyance charges and cost of removal will be met.

The Chief Engineer will have responsibility for a staff of 100 and an essential of the appointment is to ensure that the equipment of the mill is in condition to operate continuously 7 days per week, 50 weeks per year and that the cost of maintenance is economic. In addition, there is a considerable amount of development and enlargement work to be carried out in the foreseeable future in the main by Company labour.

Among the desired qualifications are personal experience of the control of the maintenance of paper-making machinery, including continuous 7-day operation; personal experience of the operation of planned maintenance; first-class professional qualifications are required. Applicants may be any age up to 50—experience is the main qualification.

Please write briefly in first instance, quoting Reference No. 825, to:—

AA LTD

ASHLEY ASSOCIATES LTD.
PETER HOUSE, MANCHESTER 1.
RETAINED TO ADVISE ON THIS APPOINTMENT
The strictest confidence will be observed and no details of candidates will be passed to clients without candidates' permission.

C 987

ENGLISH ELECTRIC

have a number of vacancies for Engineers, Designers, and Draughtsmen in the General Engineering Projects Department, at their London Office.

The Department is concerned with the layout, engineering and site construction of Power Stations (Steam, Hydro, etc.), large factory installations such as textile mills and similar work. Responsibilities run from tender to commissioning stage, calling for frequent visits to the Company's works and also sites, which may be at home or overseas.

Openings exist for:

ELECTRICAL AND CIVIL ENGINEERS

who should be graduate members of their appropriate Institution and have previous experience of Power Station equipment, foundations, and auxiliaries. These posts call for considerable initiative and design responsibilities.

DESIGNERS AND DRAUGHTSMEN, CIVIL ELECTRICAL, MECHANICAL

These are senior posts carrying attractive salaries, and whilst it is expected that candidates would possess at least an H.N.C., strong emphasis will be placed on previous experience of the type of work described above, i.e., Heavy machinery foundations, reinforced concrete and steel structures, ducting, etc. Cable runs, control panel layouts, etc., pipework, high and low pressure, craneage, turbine installations, etc.

Write giving full details to

DEPT. G.P.S., ENGLISH ELECTRIC HOUSE,
STRAND, LONDON, W.C.2

quoting reference EG599T.

D 25

THE GLACIER METAL COMPANY LIMITED

Invites applications from

YOUNG ENGINEERS

For posts in a

SPECIAL ASSIGNMENT GROUP

attached to the Chief Production Engineer at Company Headquarters.

On entering, they will be deployed to work on special projects chosen to allow them to make an immediate impact on the work of the company.

Projects are of great interest and often concern new developments; they last some months each and may take place in any of the Company's Factories in England or Scotland.

After about 6 months in the Group members are eligible for permanent positions in the Company where career prospects are excellent.

SALARY RANGE: £950 to £1350 per annum. Requirements: a good qualification, and, to warrant appointment towards the upper part of the range, some practical experience. In particular, however, the Company is seeking for these positions men showing evidence of promotion potential.

Applications should be sent to Personnel Divisional Manager (Ref. S.A.),

Glacier Metal Company, Ltd.,
Ealing Road, Alperton,
Wembley, Middlesex. C 992

HENRY WIGGIN & COMPANY LIMITED have a vacancy in their Sales Department for the following:—

MECHANICAL ENGINEER

for the development of high-temperature heat-resisting nickel alloys in the United Kingdom and Overseas. Duties will include advice to customers on the selection of heat resisting alloys for the construction of all heat engineering equipment.

Applicants should preferably be between 27 and 35 and should hold a degree or equivalent qualification, and should have had some industrial experience in the gas turbine, automotive or general high-temperature engineering.

Good salaries commensurate with age, qualifications and experience, will be paid. A car will be provided.

The Company provides excellent canteen, recreational and other welfare facilities, and operates generous Non-Contributory Pension and Life Assurance Schemes.

Applications should be made in writing, giving details of education and experience, and should be addressed to the Personnel Manager (quoting reference S.52), HENRY WIGGIN & COMPANY LIMITED, WIGGIN STREET, BIRMINGHAM 16. C 986

MALAYA

Leading British Merchant House requires CIVIL ENGINEER for the Consulting Engineers' Department of its Malayan Subsidiary Company. This department is concerned with the Engineering aspects of the management of Rubber and Palm Oil Plantation Companies. Applicants must be under 30 and preferably Graduate or Associate Members of the Institution of Civil Engineers, although holders of the Higher National Certificate with the right experience would be considered. Furnished accommodation is provided at nominal rent. Frequent paid U.K. leave with free passages. Medical Scheme. Contributory Retirement Schemes. Other terms will be discussed at interview.—BOX D 3. Offices of ENGINEERING.

The
British Steel Castings Research Association

require a

SENIOR RESEARCH ENGINEER

to be Head of the Engineering Section in the Association's modern laboratories in Sheffield to supervise the work of a team of investigators concerned with studies of plant and equipment used in steel foundries, problems relating to atmospheric pollution and industrial health, operational research in foundries and the design of castings.

Applicants should be professionally qualified mechanical engineers with several years' experience, who are interested not only in investigational work but also in applying the results of such work in industry.

The salary will be progressive and initially will be commensurate with age and experience. Good superannuation scheme and working conditions.—Applications to THE DIRECTOR, at 5, EAST BANK ROAD, SHEFFIELD, 2. C 995

PLANNING MANAGER

A rapidly expanding Company engaged in the design, manufacture and erection of low temperature process plant requires a qualified engineer to be responsible for the planning activity of the Company.

He will provide delivery estimates for use in sales proposals, direct the preparation and maintenance of central schedules for project orders and disseminate information regarding shop-hour loads, etc., and material purchasing activity for general planning and budgetary purposes.

Applicants should have extensive experience in engineering, manufacturing, construction and operations, etc., with specific knowledge in scheduling and co-ordinating these activities.

Please reply to:

Personnel Manager,
AIR PRODUCTS (G.B.) LTD.
49-50, Poland Street,
London, W.1.

C 998

FAIREY AVIATION LIMITED

Hayes, Middlesex.

VIBRATION TEST DEPARTMENT.

VIBRATION ENGINEER

required for senior post

to work on practical investigations of vibration and fatigue in helicopters.

Candidates should be graduates or hold H.N.C. with Endorsements and have several years experience in this field.

APPLICATIONS FOR THIS INTERESTING AND REWARDING POSITION SHOULD BE SENT TO THE PERSONNEL MANAGER AT HAYES, MIDDX.

D 14

English Subsidiary of Large European International High Grade Steel Company

require

Experienced Tool Steel Salesman

for

British Home Market

Successful applicants will be expected to undergo a course of training on the Continent.

Reply giving particulars to:

Lancaster, King, Ridgway & Co.,
Chartered Accountants,
Queen's College Chambers,
Paradise Street, Birmingham, 1.

D 1

AEI

MOTOR AND CONTROL GEAR DIVISION

DRAUGHTSMEN

Several Draughtsmen are required at our HUYTON (Liverpool) office for the Design of Electrical Control Gear. Previous experience in this class of work preferred but not essential. Qualified Draughtsmen on either Electrical, or light Mechanical work are invited to apply.

Several Electrical Draughtsmen are also required for the preparation of Wiring Diagrams. Positions are permanent, and the work offers excellent opportunities. These are staff positions qualifying for the Company's Pension Scheme. Full canteen facilities available. Five-day week finishing 4.30 p.m. on Fridays. Interviews will be arranged at Huyton.

Please write for application form quoting Reference S.16 to:—

Personnel Manager,

Associated Electrical Industries (Manchester) Ltd.,
Trafford Park, Manchester, 17.

C 990

THE REED PAPER GROUP

requires a

QUALIFIED MECHANICAL ENGINEER

This appointment occurs in the expanding packaging field and the person appointed will be required to take charge of a number of engineers engaged in Process Development. This is a senior position involving responsibility for technical guidance and control of staff engaged on development projects.

Applicants should have a university degree or A.M.I.Mech.E., age preferred 30-40. Applicants should have several years' experience in Process Development Work.

Excellent conditions of service include a non-contributory pension scheme and assistance with house purchase.

Written applications with full details of qualifications and career to date, should be addressed to:—
THE GROUP PERSONNEL OFFICER,
ALBERT E. REED & CO., LTD.,
LARKFIELD, Nr. MAIDSTONE, KENT,
quoting REFERENCE QME/PDDD/90.

D 22

BRITISH OXYGEN GASES LTD.

DEVELOPMENT GROUP, HARLOW

TECHNICAL ASSISTANTS

British Oxygen Gases Limited have vacancies for Technical Assistants in their Development Group. The work is in connection with the development of equipment of a specialised nature in the compressed gases field. Applicants should possess an O.N.C. or equivalent and have had some experience of test and experimental work. Housing assistance is available at Harlow. There are good prospects as the activities of this section are expanding.

Write stating brief details to the
CHIEF DEVELOPMENT ENGINEER,
BRITISH OXYGEN GASES,
PINNACLES WORKS, HARLOW.

D 21

SENIOR MECHANICAL ENGINEERING DRAUGHTSMEN required for interesting work on large chemical plant installations. Experience in this type of work is desirable but not essential and applicants with general mechanical engineering experience will be favourably considered. The posts offer opportunities and salaries consistent with experience and ability. Modern offices situated in the London E.C.4 area. Five-day week and superannuation scheme.—Applications, which will be treated in the strictest confidence, giving details of age, qualifications and experience, and quoting ref. LCL/E2/67, should be addressed to The Group Personnel Manager, LAPORTE INDUSTRIES LIMITED, HANOVER HOUSE, 14, HANOVER SQUARE, LONDON, W.1.

C 969

POTENTIAL TECHNICAL DIRECTOR

to head Engineering and Manufacturing Division of medium sized London Company. A knowledge of the Printing and/or Packaging Industry would be an advantage.

Applicants aged 30-45 should have a mechanical engineering degree or equivalent and have some experience with a Company manufacturing Capital Goods, in planning, organising and controlling manufacturing programmes.

The Company has plans for expansion and the finance available to carry them out. There are excellent prospects for a man who has the ambition, ability and experience to assist in carrying out these plans.

Commencing salary £3000-£4000 per annum. "Top Hat" Pension Scheme and car.

Full details of qualifications and experience, and present salary to BOX D5, Offices of ENGINEERING.

DUNLOP RUBBER COMPANY, LIMITED,

SPEKE,

require

DRAUGHTSMEN

for work on projects involving (*a*) Design of special purpose machines; (*b*) Plant layouts and mechanical handling systems.

Applicants must have served an engineering apprenticeship. Subsequent Drawing Office experience in the type of work as described above is an advantage. Qualifications such as O.N.C. or H.N.C. desirable, but experience is the first consideration.

Excellent opportunities for advancement within the organisation. Good holidays, pension scheme, sports and social facilities, etc.

Applications, giving full details of experience, etc., should be addressed to the PERSONNEL MANAGER, DUNLOP RUBBER CO. LTD., SPEKE, LIVERPOOL, 24.

D 24

THE GOVERNMENT OF NORTHERN NIGERIA

requires a

SENIOR WATER ENGINEER

on favourable contract terms.

QUALIFICATIONS: A University Degree or Diploma recognised by the Institute of Civil Engineers and at least two years subsequent practical experience OR has passed Parts I and II of the Institution examination or obtained exemption and has had at least five years practical experience in all. In addition, candidates should have had at least ten years experience in design, construction and maintenance of urban water supplies. Administrative experience in urban water supplies will be an advantage.

DUTIES: To undertake and supervise preliminary investigations and design of water works and water supply projects.

EMOLUMENTS: 1. *Salary*, £2752.

2. *Outfit Allowance* of £45 and Touring Equipment Allowance of £40 on first appointment.

3. *Resettlement Grant* of £37 10s. 0d. for each three months' service inclusive of earned leave, payable on satisfactory completion of contract.

4. *Children's Allowance.* £120 for one child, £216 for two, £288 for three, payable on satisfactory completion of contract.

5. *First-Class Passages* for officer and wife on appointment and on leave, and assistance towards cost of children's passages.

LEAVE: Generous home leave on full pay.

Applicants should write to:—
THE RECRUITMENT SECRETARY (OVERSEAS),
NORTHERN REGION RECRUITING AGENCY,
NIGERIA HOUSE,
9 NORTHUMBERLAND AVENUE,
LONDON, W.C.2.

or telephone TRAfalgar 1244, Extension 145.

D 30

The world's leading inventors and manufacturers of special purpose precision machinery for the Tobacco Industry have opening in their London Drawing Office for:—

SENIOR ELECTRICAL DESIGNER

Desirable applicant should be aged 30-40, with technical qualifications at least up to H.N.C. level, and with practical experience in the design and application of control circuits for small motors and electro-mechanical detector units. Some knowledge of electronics an advantage.

This opportunity is permanent and progressive; it offers immediate pensionable staff position with 3 weeks Annual Holiday and attractive commencing terms. Applications, stating age, qualifications and experience, should be personally addressed in confidence to **G. H. SALMON**

MOLINS MACHINE CO. LTD.,
Evelyn St., London, S.E.8

D 16

Applications are invited for the post of

DIRECTOR

of the newly formed

Drop Forging Research Association

The Association, which will be independent, will operate at the B.I.S.R.A. Laboratories at Hoyle Street, Sheffield. A highly qualified scientist is sought, preferably with previous experience in Research Association work, who can build up and lead a new Research Organisation. The salary, which will be substantial, will be commensurate with qualifications and experience.

Applications, which will be dealt with in strict confidence, should be sent with full particulars to:

A. L. Stuart Todd, Secretary,
Drop Forging Research Association,
245, Grove Lane, Handsworth, Birmingham 20.

C 996

BIRMINGHAM REGIONAL HOSPITAL BOARD

DEPUTY REGIONAL ENGINEER . .	£1,965 – £2,385	(Eng. 5)
ASSISTANT REGIONAL ENGINEER .	£1,625 – £2,175	(Eng. 6)
PRINCIPAL ASSISTANT ENGINEERS	£1,655 – £2,025	(Eng. 7)
MAIN GRADE ENGINEERS	£910 – £1,680	(Eng. 8)

Interesting and responsible work in Regional Engineer's Department on design and installation of mechanical and electrical services for new, and alterations to existing hospitals. Previous hospital experience desirable but not essential.

Aplications (quoting appropriate reference) naming three referees to
Secretary, 10 Augustus Road, Edgbaston, Birmingham, 15,
by 24th October, 1960, from whom further details can be obtained.

C 985

THE DISTILLERS COMPANY LIMITED

Designers and Draughtsmen

The Company has vacancies for DESIGNERS AND DRAUGHTSMEN in its Engineering Division in London, W.1. Candidates must have the Higher National Certificate in Mechanical or Electrical Engineering, as may be appropriate, and should be in the age range of 25-40. Non-contributory pension scheme and fringe benefits. Five-day week.

TWO DESIGNER DRAUGHTSMEN (MECHANICAL) with experience in industrial and chemical plant layout, piping schemes and pressure vessels.

ONE DESIGN DRAUGHTSMAN (ELECTRICAL) with experience in the layout of power and lighting installations in chemical factories, including a knowledge of flameproof equipment.

ONE INSTRUMENT DRAUGHTSMAN, with experience of instrumentation on automatic control installations for chemical and plastic plants.

Write: STAFF MANAGER,
THE DISTILLERS COMPANY LIMITED,
21/22, BOLTON STREET, LONDON, W.1.
Quote Ref. : 103/60 E.

C 989

BRITISH IRON AND STEEL FEDERATION

Applications are invited for the post of SENIOR TRANSLATOR in the Intelligence Department. Applicants (male, British nationality) should have fluent French and German, and a third language—Russian or Spanish—would be an advantage; overseas experience in the appropriate countries is a most desirable qualification. Some experience of the steel producing or consuming industries would also be an advantage.

The post is a senior one and a salary in line with the responsibilities involved will be paid.

Applications should be made in writing, and should be addressed to:
THE FINANCE AND ESTABLISHMENT DEPARTMENT (T.10.)
BRITISH IRON AND STEEL FEDERATION,
STEEL HOUSE, TOTHILL STREET, LONDON, S.W.1

D 4

AEI

ASSOCIATED ELECTRICAL INDUSTRIES LIMITED

The Research Department, Associated Electrical Industries (Manchester) Limited has vacancies for both GRADUATE and H.N.C. ENGINEERS for manufacturing research and development involving at present mainly machining processes. The activities include laboratory-based work on machine tools and processes, development work in conjunction with Manufacturing Divisions and evaluation of machine tools and associated control gear and drives. The experience and interests of applicants will be considered carefully in deciding the programmes of work.

Please write for application form quoting reference R.16 to:—

Personnel Manager,

Associated Electrical Industries (Manchester) Ltd.

Trafford Park, Manchester, 17.

G 893

MSL *have been retained to advise on the appointment of*

THE ASSISTANT WORKS MANAGER

for

WHESSOE LIMITED

Candidates should be aged 25/40 with a professional qualification in Mechanical Engineering together with experience in the control of works personnel.

The man appointed must have the personal qualities and potential to make him the prospective successor to the Works Manager of this company which is one of the foremost designers and builders of pressure vessels, heat exchangers, storage tanks (amongst the largest made), refinery units, process plants, vapour saving devices, and liquid level and control instruments for the Petroleum, Chemical, Fuel and Gas, and Nuclear Power industries. Many of its products are large in size, and following basic fabrication in the works are built and tested in the field at home and overseas. In the field of reactor pressure vessels for nuclear power, Whessoe is a world leader.

The works employees number 750, the Erection Department 750, and in its technical and administrative staff of 600, some 100 are graduates or equal. Please send brief details in confidence quoting reference F.2399 to W. F. Younger.

MANAGEMENT SELECTION LIMITED, 17 Stratton Street, London, W.1.

In no circumstance will a candidate's identity be disclosed to our client unless he gives permission after a confidential interview at which he will be given full details of the appointment. C 997

ADVERTISEMENT RATES

'Engineering' Appointments Section

CLASSIFICATIONS: Public Appointments, Appointments Open, Appointments Wanted.

TYPES OF ADVERTISEMENTS:

(a) "Appointments Illustrated" and illustrated careers advertisements: photographs or drawings may be used in conjunction with type matter.

Rates:	per page (12 in. by 9 in.)	£100
	half page	£54
	quarter page	£29

(b) Semi-display: type matter, with or without surrounding rule, name block or symbol.

Rates:	per page (12 in. by 9 in.)	£100
	per half page	£54
	quarter page	£29
	per single column inch	£2 14s.

(c) Single column "run-on" advertisements: approximately 6 words to the line, 12 lines to the inch.

Rate per line	4s. 6d.
(Minimum charge 18s.)	

SERIES DISCOUNTS: 5 per cent. on 6 insertions; 10 per cent. on 13; 15 per cent. on 26; 20 per cent, on 52.

BOX NUMBER: 2s.

COPY DATE: First post Monday.

BLOCKS: To be mounted ready for printing. Screen 100.

ORDERS TO: "Engineering" 36, Bedford Street, London, W.C.2. (Telephone TEMple Bar 3663).

Companies

Confident Forecast From Volkswagenwerk

WHATEVER the truth may be of the warnings being given on the outlook for the British car industry there is no doubt of the confidence in the West German Volkswagen firm.

The current progress report for 1959 issued by VOLKSWAGENWERK, of Wolfsburg, Lower Saxony, declares that though the motor industry is faced all over the world by a buyers' market, the Volkswagen plants are not able to meet the rising demand for their cars. An intensive programme of capital investment was continued last year. The complete engine production division was moved to the Hanover factory as part of the company's decentralisation policy. Heavy capital investment is also going on this year.

Volkswagen output last year rose by 25·9 per cent to almost 700,000 cars and commercial vehicles. In the three preceding years the increase in output had been slipping from 19·9 per cent (1956) to 17·1 per cent (1958). Average daily output during the year rose much faster in the car division than in commercial vehicles. Daily car production increased from 1,866 to 2,344; commercial vehicles from 429 to 495.

Brazilian Enterprise

Western Germany, exporting just over half of its total vehicle production, accounts for a third of the vehicle exports of the Western world. The Volkswagen share of the German exports was 46·4 per cent, against 43 per cent in the preceding year, passenger cars reaching a higher proportion than commercial vehicles. The dependence of the Volkswagen export success upon the United States market is apparent from the 193,326 vehicles sent across the Atlantic out of a total export of 404,185 units.

In Brazil, VOLKSWAGEN DO BRAZIL produced 8,383 commercial vehicles during 1959; following the Brazilian import regulations these had a "local content" of 84 per cent. 8,445 passenger cars were assembled after being imported as parts.

Rapid Progress in an Ulster Subsidiary

Within five weeks of recruiting its first workers, the new GRUNDIG subsidiary in Northern Ireland of the well known West German firm, is producing 120 tape recorders a day.

The Grundig company are using a temporary production line in an 18,000 sq. ft Government-built standard factory at Dunmurry, near Belfast. Twelve of the company's staff from Nuremberg travelled to Northern Ireland to train the local recruits.

The company is shortly moving into a 72,000 sq. ft factory at Dunmurry, now being built by the Ulster authorities. An initial labour force of 200 is expected to increase to 800 over two years. From the small standard works now in use the first consignment of an initial United States order for 8,000 tape recorders has been despatched.

Tractors in India and an Anglo-US Agreement

Close on the heels of the Indian Government's decision that allows DAVID BROWN to substantially expand their tractor production there, the company is able to announce an agreement with the BINGHAM PUMP Company, of Portland, Oregon, USA, for the manufacture and sale of pumps to the American company's designs.

India first. The original licence to David Brown's allowed only the production in India of the 14 h.p. DB2D. This has now been expanded to provide for the manufacture of the current DB850 and 950 Implematic tractors, which are of 35 and 42·5 h.p.

The Indian Government's new decision allows the local David Brown company, DAVID BROWN MAHINDRA TRACTORS, to build up to 3,500 tractors a year. The subsidiary is jointly owned with MAHINDRA AND MAHINDRA, Bombay, the India distributors for the home company.

Production at this level calls for a new factory, which is now going up near Bombay. Meantime, part of the local company's plant is being used for assembly and distribution. A consignment of s.k.d. tractors (semi-knocked down) has been shipped out from the United Kingdom. A training school, run by company engineers from Britain, is being set up in Bombay.

The pump agreement enables the Foundries Division, of David Brown, at Penistone, South Yorkshire, to produce Bingham-designed double volute single-stage centrifugal pumps and to market them throughout the Eastern hemisphere but not in Australia, New Zealand and part of Japan.

A special section has been established in the Foundries Division for the David Brown-Bingham pumps and it is expected that as production expands the range of pumps will be widened. At first the intention is to concentrate upon the oil industry which is, so far, the principal user of this type of Portland-built pump.

The Hazards of Export Publicity

The wide field over which new capital investment is spread takes in all shapes and sizes of companies. One concern, whose product is better known than their name, who have permission for important new factory building are the PASOLDS Company, makers of children's clothes.

In the last financial year Pasolds exported more than two million garments bearing their Ladybird trade mark to over 60 countries. With this sort of record the company are in a strong position to add their voice to the chorus of complaint that while foreign companies are given export encouragement, in the form of tax rebates and so on, in Britain they get nothing but exhortations.

Pasolds raise an interesting point about advertising allocations. Home advertising, they say, is a safe long-term investment. The worth of overseas advertising is constantly at the hazard of overnight variations in import policies.

The Board of Trade have granted industrial development certificates for 120,000 sq. ft of new buildings at Langley, Buckinghamshire, and construction is expected to begin this year. The company's development programme and its normal spending on new plant and machinery, will cost about £300,000.

The group net profits for the year, after tax, were £374,397 against £301,164 in the previous year.

Industrial Lubricant Chief Off to America

The constant posting of company executives in both directions across the Atlantic on sales and other visits continues.

Baron Rolf Beck (inset) chairman of

the SLIP GROUP, has flown to America where he is making a four-week tour of Canada and the United States. One of his aims is to introduce one of his companies' Molyslip lubricant supplements to North America industry. The Slip Group already have a number of industrial fuel oil additives and chemical compounds established in the dollar sales area.

Washing Machine Firm— No Final Dividend

Further confirmation that the domestic electric appliance market was in decline before the hire purchase restrictions were applied earlier this year is given by the annual report of the ADA (HALIFAX) washing machine, refrigerator and machine tool company.

The high level of production that the company had built up during the previous financial year was well maintained until December, 1959, says Lt-Col. W. D. Gibbs, the Ada chairman, in his review. But from the beginning of this year sales began to taper off under the impact of a much lower level of demand. The period of doubt as to the Chancellor of the Exchequer's intentions before the budget helped to make the situation worse and the hire purchase restrictions had a "drastic effect."

Colonel Gibbs expresses the hope that the Government will succeed in finding some method of controlling its financial policy without disturbing the normal state of consumer demand. With a trading profit reduced to £205,494 against the previous year's £350,267 no final dividend was recommended. There had earlier been an interim dividend of 10 per cent.

PHILIPS ELECTRICAL INDUSTRIES have put in a bid for all the Ada shares which they do not already own. The Ada directors have unanimously recommended acceptance of the move.

Heavy Capital Needs of Industry

The announcement by LAZARD Brothers that underwriting is going on for the £7 million ENGLISH ELECTRIC debenture issue brings to around £30 million the total of capital which is being currently raised by industry.

The BOWATER issue in the region of £10 million, the PLESSEY Rights issue of £10 million and the issue by the GEORGE COHEN 600 Group for a large but not yet announced sum all go to make up the £30 million.

Circularising the English Electric stockholders, Lord Nelson, the chairman, points to four contributors to the company's growth, all of which need capital. Both manufacture and the testing of new equipment in the electric power side of English Electric involve technical developments for which substantial spending is necessary. The Canadian MARCONI company has obtained a licence for television on the English speaking transmission in the Montreal area. Another capital consuming development is the formation with AUTOMATIC TELEPHONE AND ELECTRIC Company and with ERICSSON TELEPHONES of a company through which it is intended to increase the volume of transistor output and thus reduce the manufacturing costs.

Lord Nelson's fourth point was the conclusion of the negotiations by the BRITISH AIRCRAFT CORPORATION for the purchase of a 70 per cent holding in HUNTING AIRCRAFT. As a member firm of BAC English Electric has paid its proportion of the price.

The major issues on the grand scale by the industrial leaders are not alone in the capital field. Certain smaller concerns are also at various stages in raising additional capital on the market.

Collapsible Gates and Nylon Grilles

The depressed conditions in the building industry in the first six months of the past financial year are reported by the chairman of the BRADY GROUP to have improved, giving the companies in the group increases in activity more than those experienced in normal periods of good trading.

The Brady Group includes among its products various types of shutter doors, metal and nylon rolling grilles, electric lifts, Batley concrete garages, rubber doors and ornamental ironwork. The group consolidated profit for the year rose by £27,000 to £398,000.

BROOKES & COMPANY (1925) became a wholly owned subsidiary during the year, furthering the group's interests in architectural metal work and adding, in Manchester, to the capacity of the group for the production of sliding shutter doors. Conditions in the building industry compelled a reduction in the company's prices in order to maintain the share of the work available but the order book is now considerably increased and a better return is being made.

The results for the group so far this year are described by the chairman, Mr. R. R. Seymour, as good and order books are at record levels.

Safety Comes to Electrostatic Spraying

Electrostatic paint spraying is economical both in time and materials. The Felici electrostatic generator makes the process safe and cuts the capital cost.

THE advent of the Felici electrostatic generator, with its flat voltage/current characteristic, its inherently safe method of operation and its small size, might well revolutionise the paint spraying business. The first equipment to use this generator is the Statron developed by Société Anonyme de Machines Electrostatiques (SAMES), of Grenoble, France.

The Statron comprises an electrostatic generator producing 90,000 V, an atomising spray gun with an adjustable output up to 5 gallons of paint per hour and a feeding system for the paint. This feeding system may be based on a gravity tank situated above the gun, a paint cylinder connected to a source of compressed air, or simply a small paint pump.

In operation, paint at a pressure of about 10 lb per sq. in is delivered to the spray gun, which weighs 12 oz, together with electrical power at 24 V and 90,000 V; the lower voltage being used to drive a small electric motor incorporated in the gun and the higher voltage to charge the paint. The paint is led to a cylindrical cup which is rotated at 3,000 r.p.m. by the motor, and the electrically charged paint then spins out of the end of the cup in an atomised spray due to the centrifugal force imparted by the revolving cup. The electrostatic field which is present also assists in the atomisation of the paint. Charging of the paint (negatively to 90 kV) helps in the dispersion because particles are similarly charged and hence mutually repellent. Thus, the spray gun produces a cloud of finely-dispersed negatively-charged paint particles which are attracted to any earthed object in their path.

In the great majority of cases this cloud of paint will cover all sides of an article merely by spraying towards one face of the article. It will cover the surfaces of the nooks and crannies of an object without any particular effort or skill on the part of the operator—indeed, a first class spraying job can be done by unskilled labour after only a few minutes instruction. The main advantage, however, is probably the fact that overspray is virtually eliminated.

A survey in Germany produced the figures for savings of time and materials using the Statron which are shown in the accompanying table.

It will be appreciated that the Statron can be used to spray any material which is an electrical conductor, even in the mildest way. To the indiscriminating paint, then, the operator being earthed represents just as good a target as the work and it is not impossible for him to spray himself. This is why the gun, shown in the accompanying illustrations, is fairly long to keep the paint away from him. So long as the gun is kept near the work when it is operating, 6 in is about the average, there is no danger of anything untoward occurring.

The charge is imparted to the paint in the spinning cup which is connected to the electrostatic generator and insulated from the rest of the gun. This means that the specific resistance of the paint must be high in order to prevent too much current running down the paint line to earth. It is recommended that the specific resistance should be between the following limits: 2×10^6 and 5×10^7 ohm. cm. The specific resistance of a paint can be adjusted to a satisfactory value by adding one solvent or another—for example, alcohol decreases resistance and petrol increases resistance. The upper limit of the specific resistance is fixed in order to facilitate transmission of the charge to the paint. If the resistance is too high, it is difficult to charge up the paint particles. The only paints which cannot be used with this equipment are those containing water. This is because of their high conductivity.

The electrostatic generator is housed in a metal box measuring approximately 26 in by 13 in by 11½ in and which weighs about 13½ lb. The short circuit current of the generator is 0·2 mA. This is well below the lethal dose and the equipment can be earthed to the human body without discomfort or danger.

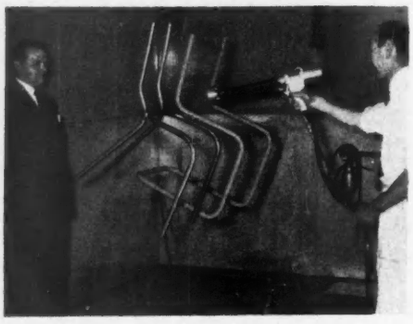
Each gun is supplied with four atomising heads of different sizes. Selection of the head is determined by the amount of paint required from the gun—the smallest, 50 mm. diameter, nozzle sprays between 4 and 6 litres an hour, and the largest, 100 mm. diameter, nozzle gives 25 to 30 litres an hour.

The considerable savings in man-hours and materials should make electrostatic spraying very attractive indeed to anyone who does a lot of spraying. There must be many large-scale applications for this equipment where fixed installations using one or more Statron units could speed up the production flow and cut material losses to a negligible amount. An excellent example of this is the motor car industry where bodies could possibly be sprayed in a fraction of the time now taken without the use of skilled labour and saving many thousands of pounds per annum in paint wastage. In addition, less floor space would be required and rejects could probably be reduced.

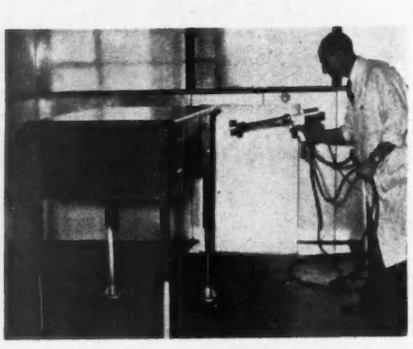
So far as operator health and his working atmosphere are concerned, the usual problems are reduced by electrostatic spraying. There is no paint fog and ventilation is required only to remove solvent vapours.

The Statron is being marketed in the UK and Commonwealth by Aerostyle Limited, of Sunbeam Road, London, NW11.

Object	Time saving, per cent	Material saving, per cent
Tubular articles, i.e., tubular furniture	60	75
Gratings and wire mesh fencing	80	85
Scaffolding	60	65
Angle sections	40	60
Large water heaters	—	60

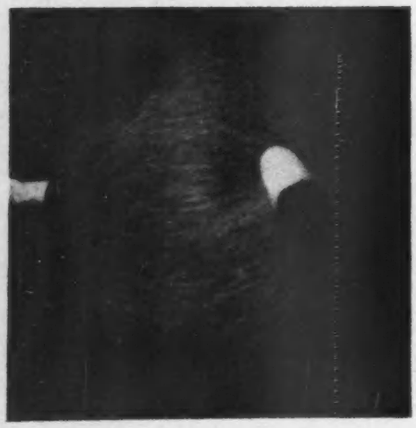


Overspray is eliminated.

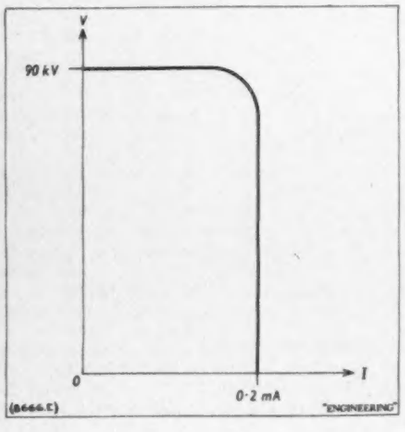


A wide range of materials can be sprayed

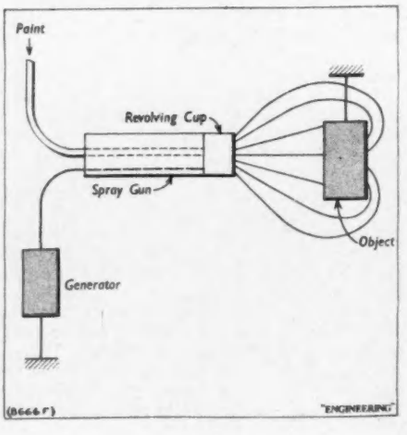
The paint wraps all round the object.



The voltage/current characteristic.



Schematic diagram of the circuit.



Controlling Combustion in an Open Hearth Furnace

The air supplied to an open hearth furnace is used for two purposes: namely to burn the fuel and to provide oxygen needed for metallurgical reactions in the furnace. Combustion control is provided on many furnaces by a fuel/air ratio controller, together with a furnace pressure controller which limits the amount of air drawn through furnace doors and other openings to the practicable minimum under these conditions. This type of control system is not really adequate because the ability of the steel to accept oxygen varies from heat to heat, from reversal to reversal, and even within a reversal.

A control system is needed which will provide sufficient oxygen for metallurgical reactions without allowing combustion to become inefficient through using too much air. Such a system can be based on the use of a paramagnetic oxygen analyser, the purpose of which is to monitor continuously the oxygen concentration in the waste gas from the furnace.

The quantity of oxygen in the gases leaving the furnace shows whether the correct amount of air for both fuel combustion and furnace oxidation is being supplied to the furnace. The signal from a paramagnetic oxygen analyser can, therefore, be used to continuously adjust the quantity of air supplied to the furnace so as to give more complete control of combustion than is possible with a fuel/air ratio controller.

The first step in applying the analyser is to construct and operate a reliable gas sampling system which, together with the analyser, will give the fast response necessary for successful control. A sampling system which satisfies this requirement has now been developed, and it can be installed at the stage level of any furnace having steam, cool water, and a drain available below stage level.

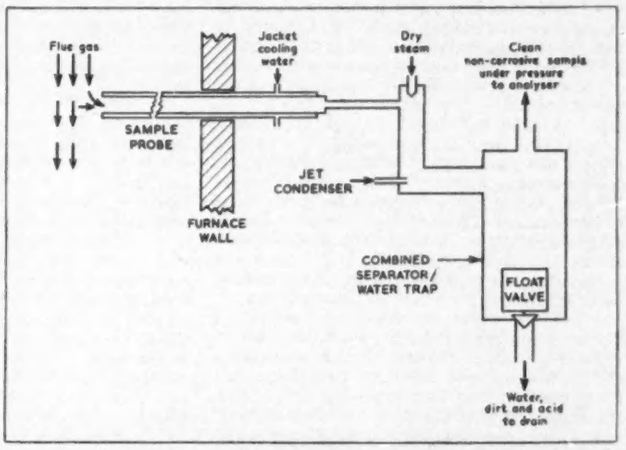
The sampling system uses a steam ejector to compress the sample to between 6 and 8 lb per sq. in. Water is sprayed into the mixture of sample and steam, and the cool clean sample can then be transmitted along anything up to 200 ft of ¼ in copper tube to the analyser, while the water collects into a separator and is allowed to flow to a drain. Output is from ½ to 1 cu. ft per min of sample at 6 to 8 lb per sq. in, which is sufficient to sweep out the system in a few seconds; and the overall delay time in the furnace sampling system and analyser is sufficiently small to give a response at the analyser 20 to 30 seconds after a sudden change in the fuel/air ratio at the burner, and 90 per cent response in 45 to 50 seconds. Little maintenance is required and a thorough weekly overhaul will keep the equipment running reliably for long periods.

A separate sampling system must be provided at each end of the furnace, and when the furnace reverses it automatically transmits a signal which opens a valve controlling the sample at the waste gas downtake and closes the valve controlling the sample from the air uptake. Experimentally, this system has been used on an open hearth furnace, with an operator manually controlling the furnace air damper so as to give a constant concentration of oxygen in the waste gas.

The next stage in the development of this idea will be to arrange a control linkage to the air damper so that combustion is automatically controlled by the analyser signal. This has not yet been tried on a British open hearth furnace but there is such a control operating on a soaking pit.

The control of a soaking pit is basically similar to the open hearth furnace but the conditions are less arduous and a simpler sampling system can be used. At this pit a fuel/air ratio controller is used and the signal from the oxygen analyser changes the value of the fuel/air ratio within a limited range to give a constant exit gas composition. The range of operation of the analyser control is limited so that when a sudden change, too fast for the response of the analyser, occurs, reasonable control action is taken during the short period before the analyser can accurately follow the change. At this pit, combustion control with an oxygen analyser has improved pit operation and reduced fuel consumption.

Fuller details of the system can be found in BISRA report SM/AH/123/59 entitled "Waste Gas Analysis for Open-Hearth Furnace Combustion Control." Copies of this report can be obtained from 11 Park Lane, London, W1.



Schematic representation of the waste gas sampling system. It enables a cool clean sample of gas to be transmitted along anything up to 200 ft of copper pipe.

Spot Welders and Plasma Jets

The British Oxygen Company Limited showed two interesting developments at the recent SBAC Show at Farnborough. They were a argon arc spot welding torch and a plasma jet.

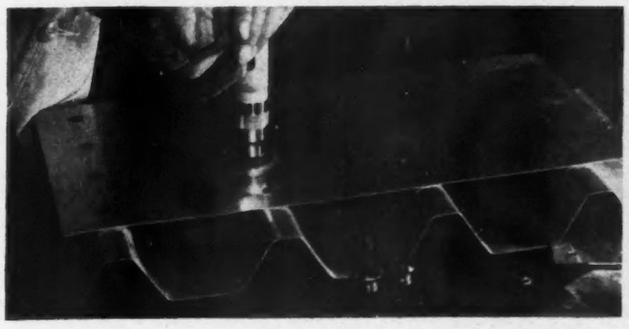
The spot welding torch will supersede the present standard torch in 1961. The one shown was a prototype model. This equipment is simple to use and cheap to run. Access to only one side of a joint is required and spot welds can be made with one hand by semi-skilled labour. Shear values compare favourably with those from resistance welding.

Welding conditions are preset and the process is semi-automatic. Only occasional changing and resetting of the tungsten electrode is required. A good surface finish is ensured and generally no grinding or polishing is needed in the majority of applications.

The torch is water cooled and can carry currents up to 250 A. It is switched on by a button type micro-switch in the handle. The back-entry collet enables the electrode to be replaced or adjusted simply and quickly, without removing the ceramic adaptor or argon shield. With interchangeable nozzles, the torch can be used for making spot welds in horizontal or vertical positions, on narrow flanges, or on 90° outside corner joints.

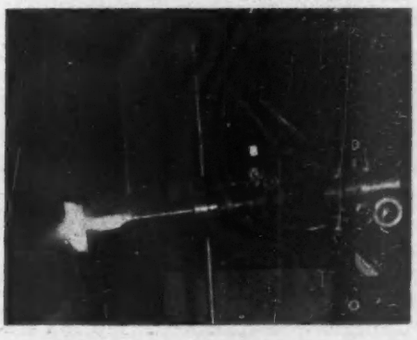
The plasma jet, a high temperature torch, was designed by British Oxygen Research and Development Limited. It has many uses in the aircraft, rocket, nuclear and chemical engineering fields. It is particularly suitable for applying coatings of high melting point or reactive material by spraying.

Successfully deposited are high melting point materials such as zirconia, alumina and titania; refractory and reactive materials including tungsten, tantalum and silicon; chemically-resistant materials such as titanium and stainless steel, and wear resisting materials like tungsten carbide and nickel-chromium-boron alloys.



(Left) The prototype argon arc spot welding torch.

(Right) The plasma jet —a new high temperature torch.



Grading Coal and Dirt at Lea Hall Pit

Feeding a power station direct by conveyor, linked to the Midlands and London directly by rail, Lea Hall colliery grades its own and imported coal to suit various consumers. It will also grade dirt for disposal in various ways.

ALONGSIDE the National Coal Board's new colliery at Lea Hall, Staffordshire, a new power station is taking shape. The first of its five 120 MW generating sets will be in operation by the end of this year. The anticipated output of the colliery is to fulfill the requirements of the power station. As a result the decision was taken to feed the station direct from the colliery by way of twin belt-conveyors. The power station has no sidings, tipplers, or road-borne coal reception hoppers. But to provide continuity of supplies during holiday periods or emergencies, a 23 acre coal-storage space is planned, having an ultimate capacity of 400,000 tons.

Not all of the coal burnt by the power station, however, need come from the Lea Hall colliery; nor will the output of the colliery be devoted solely to the needs of the power station. To provide necessary flexibility of operations, a comprehensive coal handling installation has been built at the Lea Hall pit head. This separates and grades mixtures of coal and dirt both from the Lea Hall colliery and from adjacent collieries in the Cannock area, which can deliver their outputs to Lea Hall by rail.

Coal in the plant is separated into two grades. Industrial coal for the adjacent power station, which will ultimately take about half of the colliery output, leaves the plant by conveyor. Best coal, for domestic and high-grade industrial use, leaves by rail. Another transport system in the plant deals with dirt. The complete installation was supplied by the General Electric Company Limited. Lea Hall is well situated to supply consumers in the Stafford and Lichfield areas, and also in the industrial centres between Birmingham and Wolverhampton. It is also on the main route for London and the South of England.

INITIAL SORTING

A diagram of the coal handling plant is shown in the drawing. At each of the shafts is installed a tippler designed to tip one 3 ton coal-capacity mine car every 30 sec. It feeds a 48 in wide apron feeder for coal or a similar feeder for dirt. Discharge to either of the feeders is controlled by a flopper chute located under the tippler.

Best coal raised at the upcast shaft is discharged to a 48 in wide conveyor and passed to the best-coal conveyor by way of a bifurcation chute using a flopper device. Untreated raw coal is first screened at 6 in and the large coal delivered to a picking belt for hand selection and cleaning. Hand removal of inferior coal and dirt is carried out at this stage and the discard fed to the industrial-coal and dirt handling systems.

The best coal below 6 in is then transported by a 600 ton per hour trough conveyor 48 in wide, to the washery plant, at present under erection. This handles coal sized between ¼ in and 6 in. The conveyor belt feeds into a 250 ton bunker equipped with an anti-breakage spiral, from the bottom of which coal is fed at a controlled rate to a large extraction screen for the removal of ¼ in coal. The small coal is returned by a conveying system to one of the blending bunkers for making up the power-station feed.

The 6 to ¼ in material then passes into a " dense medium " washery. Finely ground barytes acts as a suspension medium, separating the clean coal from other constituents. This is a continuous process: raw coal is delivered to the washery and clean coal, medium quality material, and discard leave the vessel separately. All traces of barytes are removed by spraying the outputs with clean water. Dirt joins the main stream of discard in the plant, and inferior or medium quality coal passes to the power station feed line. The clean coal is sized on classifying screens into cobbles of 6 to 3 in and nuts of 3 to 1½ in, for the domestic market, and nuts of 1½ to ¼ in for industrial use. Finally, the products are loaded into railway wagons by loading booms, with the minimum of degradation. Alternatively, 3 to ¼ in clean coal can be fed to bunkers for loading into lorries.

INDUSTRIAL COAL SYSTEM

Industrial grade coal is diverted at the bifurcation chute to the industrial coal conveyor. This is also 48 in wide, of 600 ton per hour capacity and delivers to a single-deck Gyrex scalping screen which extracts coal under 6 in. Oversize material passes on to a 60 in wide picking belt, where large stone, timber, and metal can be removed by hand, before the large coal is fed to crushing equipment. A Pegson 25B gyratory crusher is used and its output is mixed with the under 6 in coal and passed over two 72 in by 192 in Gyrex screens in tandem to remove coal under 1½ in. The oversize coal then passes through a 104 in by 42 in Pennsylvania hammermill secondary crusher. The crushing system installed is capable of dealing with large coal of 24 in cube and coals with a large variety of hardnesses.

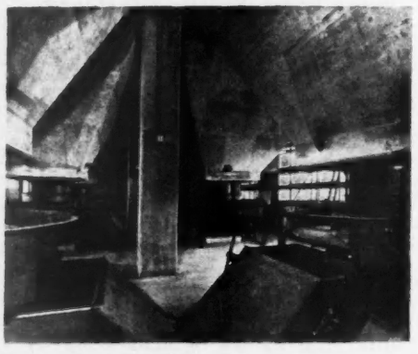
The output from the hammermills is mixed with the coal under 1½ in that by-passes them and the complete mixture of coals under 1½ in forms the main constituent for the power station supply. This coal is transported to blending bunkers by a 4½ in wide belt conveyor. A radial conveyor fitted over the bunkers provides facilities for feeding to each of the three 150 ton capacity compartments.

IMPORT COAL SYSTEM

The imported-coal system has the greatest flexibility of operation. It can deal with 300 tons per hour of rail-borne coal for crushing, or if the coal is best-quality it can transport an equal amount to the washery, or it can pass 500 tons per hour of imported dirt to the dirt crushing system.

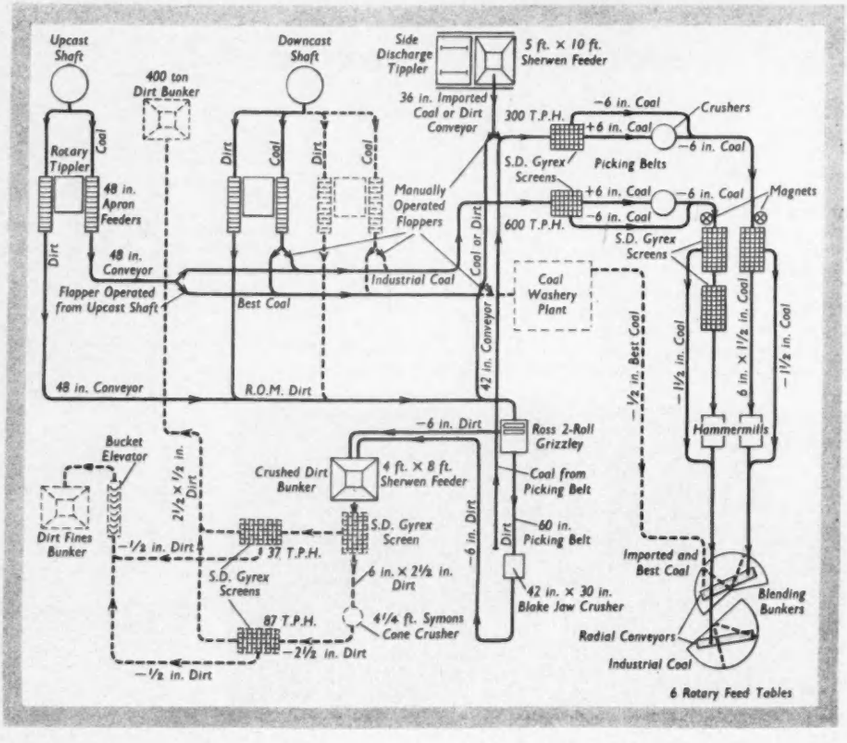
Rail-borne coal is discharged into a bunker by means of a Fraser and Chalmers side-discharge tippler, and is removed by a 5 ft by 10 ft Sherwen electromagnetic vibrating feeder to be fed to a 36 in wide conveyor. This delivers to a 300 tons per hour Gyrex screen. The process is then similar to that used for the pits own industrial coal, except that somewhat smaller capacities are involved.

The coal-blending plant consists of six 150 ton capacity bunkers fed by radial conveyors. Normally three bunkers will be allocated for the



(Right) Six GEC rotary feed tables remove the coal from the blending bunkers.

(Below) Coal for industrial use goes through crushing processes to reduce it to 1½ in and under. Best coal goes to the washery and then is graded in sizes between 6 in and ½ in for domestic and high-grade industrial use.



Lea Hall product, one for imported industrial coal, and two for the best coal under ¼ in which is screened out at the washery. Blending will be carried out by 9 ft diameter feed tables at the discharge points of the bunkers. These will feed a 36 in wide conveyor (or a similar stand-by conveyor) that runs to the reception hopper of the Central Electricity Generating Board power station. The two belts are fitted with weighers and samplers, with a sampling house located close to the reception hopper.

DIRT HANDLING SYSTEM

In addition to the various coal-handling systems a dirt-handling system has been installed. When dirt is sent up either shaft, it is discharged by a rotary car-tippler on to a 48 in wide apron feeder, and from there on to a 48 in conveyor linking the two shafts. The dirt then passes to a Ross two-roll grizzley screen set at 6 in. The undersize is conveyed to a crushed-dirt bunker. The oversize is fed via a 60 in picking belt to a 42 in by 30 in Blake jaw crusher. This reduces the dirt to under 6 in, in which state it enters the crushed-dirt bunker to join the other dirt. Coal picked off by hand from the picking belt is conveyed to the industrial coal line.

At present, dirt is removed from the bunker for direct disposal. However, GEC have also received an order for the extension of this plant, to facilitate stowage of the stone underground.

Under the new contract, a 4 ft by 8 ft Sherwen feeder with a capacity of 350 tons per hour will remove the dirt from the crushed-dirt bunker and a 30 in belt will convey it to a 72 in by 168 in Gyrex screen with a 2½ in mesh. The oversize from the screen will be reduced to below 2½ in by means of a standard 4¼ ft Symons cone crusher. The fines from the screen and the crusher will then be screened by ½ in single-deck Gyrex units of 37 tons per hour and 87 tons per hour capacity. Undersize from these screens will feed a 24 in wide bucket elevator which will deposit it into a fines dirt bunker. The oversize, however (that is 2½ in to ½ in) from both screens will feed on to a common conveyor taking it back to a 400 ton storage bunker located at the head of the upcast shaft. Two 4 ft by 10 ft Sherwen feeders will be installed to remove this dirt from the bunker into mine cars, for transport down the mine.

The dirt handling plant can also accept imported dirt. The side-discharge tippler at the railway siding feeds a 36 in conveyor. A flopper device directs the dirt on to a further conveyor which in future will handle both imported coal and dirt. This feeds the two-roll grizzley.

In the power station, each of the five boilers will produce about 830,000 lb of steam per hour by consuming more than 50 tons of coal in the same time. The coal is pulverised and hot air is used to convey it and dry it before ignition in the combustion chambers.

High-Pressure Radiant Heating for Diesel Depot

The railway modernisation programme means not only new rolling stock but also new facilities for handling that stock. New maintenance depots for diesel locomotives are being built, for example. One of the first of these, commissioned in May, is the Finsbury Park Diesel Depot. And of the innovations to railway practice that can be singled out there, the heating system deserves special mention.

A high-pressure hot water system is installed, with an oil-fired boiler that can burn a proportion of sump oil from the locomotives as well as heavy fuel oil. Mr. T. C. B. Miller, chief mechanical and electrical engineer, Eastern Region, was responsible for the services in the depot. The installation of the piped services, notably the heating, was carried out by Brightside Heating and Engineering Company Limited, Ecclesfield, Sheffield.

The main shed is a steel frame structure with a single span of 111 ft 6 in. Inside are six tracks and seven working platforms at footplate level. It would be uneconomic to heat up all the air in such a large shed. Therefore, to distribute the heat efficiently where it is most needed—in the working zones between the locomotives—radiant panels are used. These are "Brightrad" strip units and they have been combined with strip "Ionlite" cold cathode lighting, which serves the same areas. High temperature dual strip panels 10 in wide are suspended over the platforms, with the lights carried at intervals between them. The arrangement can be seen in the illustration. In addition, low temperature panels are fixed under the T-shaped platforms for the comfort of the men working low down on the locomotives. Workshops and stores are also heated by radiant panels. Some 5,640 ft of radiant strip have been installed in the first stage of the depot's construction.

TEMPERATURE DISTRIBUTION

The radiant panels are heated by water at 150 lb per sq. in gauge. The panels in the roof are at high temperatures, with a maximum of 340° F flow and 280° F return, on a cold winter's day. Those at lower levels operate at a maximum of 200° F and 180° F return. For an outside air temperature of 30° F and an air change rate of two an hour, the system has been designed to give temperatures of 60° F, 55° F, 70° F and 65 °F in the workshops, stores, offices, and messrooms, respectively.

Oil for the boiler is delivered by rail to two main storage tanks of 9,000 gallons capacity. As oil with a viscosity of 950 sec Redwood is used, the rail delivery tanks are steam heated to facilitate offloading. The steam generator for this purpose is heated by high pressure hot water from the main circuit at 340° F. It is fully automatic and can generate 250 lb of steam per hour at a pressure of 25 lb per sq. in. The temperature of the oil in the main storage tanks is maintained at 80° F by two 5 kW immersion heaters. Two further tanks of 2,000 gallons hold waste sump oil pumped from the locomotive shed.

The present boiler plant consists of a single La Mont boiler capable of 4·5 million Btu per hour. Provision has been made for the installation of a second of this type when the depot is extended. Photoelectric smoke alarm equipment has been installed and a continuous record of smoke density is kept.

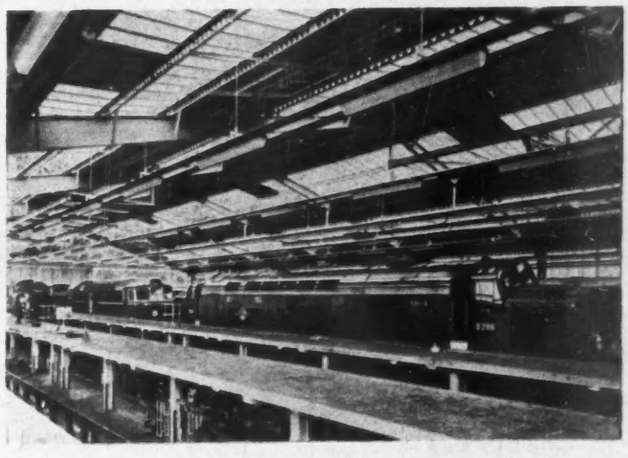
A nitrogen pressurisation unit attached to the main suction header maintains the water at a pressure of 150 lb per sq. in. Use of this gas prevents the absorption of oxygen by the water to a large extent, and water treatment is not considered necessary. Nitrogen is fed from a high pressure cylinder to two working pressure vessels. One is 5 ft diameter and 8 ft high and operates between 2 and 25 lb per sq. in. The other is 3 ft diameter and 5 ft long and is maintained at the circuit pressure of 150 lb per sq. in.

The circuit-pressure vessel is connected, from below the low water level, to the main suction header and also to below the low water level of the low-pressure, or spill, vessel. A multi-stage pump, with automatic starting, transfers water from the spill vessel to the circuit-pressure vessel, maintaining the water level in the latter. An overflow pipe and valve from the circuit-pressure vessel to the spill vessel is fitted in case the water level rises too high. Should sudden leaks occur in the system, a make-up feed pump capable of supplying 10 gallons per minute from a cold water storage tank to the spill vessel is installed. But losses through pump and valve glands are normally negligible. The full water expansion of the system can be held in the spill vessel. The set is fully automatic and has its own alarm system. Circuit pressure is maintained at the desired value irrespective of the fluctuating water temperatures.

High-pressure hot water flows at 95 gallons per minute from the main flow header at a maximum temperature of 340° F. About 10 gallons per minute is bled off to a three-way low temperature mixing valve and the remainder passes to a three-way high temperature mixing valve, where it is mixed with a proportion of the return high-temperature water.

Two 7½ h.p. pumps, one a standby, circulate the high temperature water through the depot; and two 5 h.p. pumps, one a standby, circulate the low-temperature water. All pumps have been fitted with replaceable impellers so that their capacities can be doubled with later extension of the depot. The bearings of all four pumps are cooled by water circulated by a ½ h.p. pump. The mixing valves, which are motorised, are controlled by inside and outside thermostats which register, with all other instruments, on a control panel in the boiler house.

The first take-off from the high temperature supply is to a battery of 12 Brightrad single-sided radiant panels, each of which is 8 ft long by 4 ft wide, positioned over the main entrance of the shed. These create a warm air curtain which prevents excessive loss of heat when the doors are opened for a locomotive to leave or enter the shed. Other take-offs lead to the seven pairs of panels which run the length of the shed. These are painted on their lower faces with a dark brown matt finish; their upper sides are backed with aluminium foil to render upward losses negligible.



Finsbury Park diesel depot is heated by radiant panels running each side of the cold cathode lighting. They are heated by water at 340° F and 150 lb per sq. in pressure.

On the Shelf

By Frank H. Smith

MY REGULAR reader will know that my search for the unusual and exotic takes me to even further away corners than those explored by proprietors of gimmicky eateries and travelogue TV types. Thus we have "Review of Sixty Years of Fluid Mechanics in Japan" in *Reports of the Institute of High Speed Mechanics* of Tôhoku University, Volume II. This is an *Applied Mechanics Reviews* type article, and where a reference number appears in the text it may cover a number of references in the final bibliography. Thus, after a reference to cascade flow in the main body there is a figure (3) and reference to (3) in the bibliography uncovers 26 references.

With their July-December list, Macmillans are sending their "regulars" a reply-paid postcard on which one can indicate the subjects in which one is particularly interested. This I can understand, but it is part of the witchcraft of bookery that I do not understand that they ask for the name and address of my regular bookseller. However—they say it helps. The list I mention above is a quite interesting and attractive one with some titles to interest readers of this column.

Sweet and Maxwell's lists of law books produce some strange bedfellows. A recent leaflet headed "Important New Supplements 1959-60" contained Hanson's *Death Duties* (10th ed.), Tolstoy's *Divorce and Matrimonial Causes* (4th ed.), Jackson and Muir Watt's *Agricultural Holdings* (11th ed.), Walford's *Sale of Land* (2nd ed.), Newport and Plunkett's *Income Tax*, and Samuels's *Factory Law* (6th ed.). All of these have supplements bringing them up to date.

One for the supplement. A Big Firm of publishers rang me the other day to ask if I knew what aeronomy was. No I ses, but if they find out will they be afther telling me. The query rose from a forthcoming meeting publicised by DSIR so the fellow had the nous to ring DSIR and comes back at me with the information that it's the study of the chemical properties of the upper atmosphere. Probably one of those new terms circumscribed by the celebrated Van Allen radiation belt.

We have heard a lot (and will hear a lot more) of the Commonwealth Technical Training Week to happen 29 May to 4 June, 1961. This is, I believe, Duke-inspired. An explanatory preliminary booklet is available from the City and Guilds of London Institute, 76 Portland Place, London, W1, and therein will be found a foreword by H.R.H., a list of the committees, aims and objects, suggested activities with notes and so forth.

If the Liberal party wants some hints on how to get more members, I commend a new 16 mm sound colour film issued by the US National Bureau of Standards. It is called "Trapping of Free Radicals at Low Temperatures," and probably has something to do with Esquimaux politics. Running time 13½ minutes, cost $54·64 f.o.b., from Office of Technical Information, National Bureau of Standards, Washington 25, D.C.

I believe there is a saying that there is beauty in a pig if you know where to look for it. Be that as it may, Max Parrish in their autumn list, 55 Queen Anne Street, London, W1, add *The Beauty of Railways* (30*s*) to their beauties of dogs, cats, horses, gliding. One notices, too, that in the spring they are bringing out *Sir George Cayley; the Inventor of the Aeroplane*, by Pritchard.

Consultants Bureau (227 West 17th Street, New York 11), the translation people, have renewed contracts to translate 23 Russian journals. This renewal business makes a continuous run look a bit chancy. But perhaps Russian will not always be fashionable?

Plasma Diagnosis

Approaches to Thermonuclear Power. By R. F. SAXE. Nuclear Engineering Monograph No. 10. *Temple Press.* (12*s* 6*d*)

Nuclear Fusion. Edited by WILLIAM P. ALLIS. Second Geneva Series on the Peaceful Uses of Atomic Energy. *Van Nostrand, New Jersey, and London.* (94*s*)

The short monograph by Dr. Saxe is a useful review of fusion research. The author discusses the physics of the nuclear fusion reactions and states the equilibrium conditions required to ensure that the energy yield exceeds the *bremsstrahlung* and magnetic radiation losses, assuming that the system contains no impurities.

A valuable mathematical discussion of the properties of a high-temperature plasma is given, starting from the linearised equation of mass motion. The simplifying assumptions used are not too clearly stated, and while the chapter repays study, some care is required to appreciate the limitations contained in some of the general results given. The chapter concludes with a brief consideration of hydromagnetic instabilities and the formation of shock waves.

The remainder of the monograph discusses the linear pinch, the toroidal pinch and mirror devices. While these are three important experimental approaches to fusion research, the monograph makes no mention of several other experiments in progress.

The monograph is well-written and will meet a need as an introduction to fusion research for final-year physics and engineering undergraduates and research workers entering the field. The chapter summaries provided by the author are particularly valuable. This first edition has an adequate index, but the rather short bibliography provided could be extended to indicate general reading on the experimental approaches not discussed.

The emphasis in the title on thermonuclear power is perhaps unfortunate; as the author points out in his conclusions, the experimental devices described are producing power densities at best 10^{16} times lower than the fission reactors. Remembering that ten years of technological effort has barely justified fission power, we must surely accept that fusion will be for a long time entirely in the research domain. Such research into the behaviour of a plasma should be viewed in the same way as research in high-energy nuclear physics. Authors, editors and publishers should be discouraged from using titles or presentations which imply that the subject can as yet be included in the realms of economic or even feasible engineering.

Nuclear Fusion, by Professor W. P. Allis, is a carefully prepared review of the fusion research work reported at the 1958 Geneva Conference. The author discusses 98 of the 111 fusion papers presented at Geneva in the eleven chapters of what must be an essential reference book for workers in the fusion field.

A short introduction is followed by a review of the eight survey papers presented. A detailed discussion of plasma diagnostic techniques is followed by a chapter devoted to the interaction of plasmas and electromagnetic waves in which the theory of high-frequency plasma oscillation is presented mathematically. The theoretical content is completed in two carefully prepared chapters dealing with mathematical formulation of the problems of plasma stability and plasma dynamics.

The second half of the book is devoted to the various experimental approaches, with the work by the University of California Research Laboratory on the Pyrotron heading a comprehensive list. A rather short discussion on the theta-type pinches is followed by a detailed discussion of injection machines, based largely on the Oak Ridge work, although both the Russian Ogra and the Astron are included in this classification.

The experimental and theoretical work of the Princeton group is described in a full chapter on the Stellarator; the chapter on sustained pinches is devoted very largely to the work carried out on Zeta, although the important paper (1025) on helical instabilities receives special attention. Eleven papers are reviewed in the last chapter on dynamic pinches, which describes the important instability studies carried out at Los Alamos.

The brief abstracts heading the chapters give a useful indication of the work covered, and each chapter has a very full bibliography. A comprehensive index is provided, while the appendix mentions the thirteen papers not discussed in the book, and includes a useful list of the 111 Geneva papers on fusion. The author has rendered a valuable service by re-presenting the large amount of information in an organised manner, and the work will be an important reference book for all laboratories engaged in plasma or fusion research.

D. R. CHICK

How to Transmit Mechanical Power

Maschinenelemente. By G. NIEMANN. Volume 2: Getriebe. *Springer-Verlag, Heidelberger Platz 3, Berlin-Wilmersdorf.* (31·50 *DM*)

The many kinds of mechanism used in the transmission of power, including gear, chain, belt and friction drives, provide the subject of Professor Niemann's book. It is the second volume of two devoted to machine elements, and carries a stage further the treatment of the subject begun in volume one. This first volume has recently been reprinted and is mainly concerned with mechanical methods of attachment, that is, with welding, screwing and so on, and with shafts and bearings.

Although most of the basic mechanisms discussed in volume two have been in use for many years (in some cases probably hundreds of years), the state of knowledge concerning them is by no means complete and much useful research work in the various related fields is currently being conducted, both in this country and abroad. In the forefront of this work are the technical universities in Germany. Professor Niemann, of the Technical University of Munich, has in the past concentrated largely on gearing research, and papers on a variety of aspects have appeared under his name.

As author of a book, such as the present one, he is, therefore, in the happy position of being able to draw extensively on his own experience and on results obtained in the Gearing and Mechanisms Research Laboratory of the Technical University of Munich. Indeed, in his introduction to the book, the author states that its publication was delayed for some time to permit the completion of tests, which were being carried out specifically to clarify some doubtful points in the text. It is quite obvious, therefore, that the information contained here is as up to date as it possibly can be in a volume of this sort. For the practising engineer this is, of course, of considerable importance, especially as few will have the time or opportunity to read the large number of individual papers published every year.

Apart from interesting the qualified engineer this book is also aimed at the advanced technical student. Here again Professor Niemann's university experience stands him in good stead, and he has managed to produce a book which, while

perhaps rather too detailed for most engineering courses, will nevertheless appeal to the student who wishes to keep ahead of modern developments in his subject.

The scope of the book is clearly demonstrated by a short summary of its contents. The first chapter compares the various main types of transmission mechanism from the viewpoint of relative efficiency, field of application and initial and running costs. Some general equations of motion are also given for each type. The second chapter concentrates on gearing (as being the most widely used transmission mechanism) and deals successively with tooth geometry, efficiency, lubrication, gear noise and manufacturing methods. In the remainder of the book each chapter is devoted to a detailed study of one particular mechanism, such as spur gears, bevel bears, worm gears, screws, chain drives, belt drives, friction drives, friction clutches and brakes and finally unidirectional drives such as ratchets.

In each case the general treatment of the subject is similar. Each chapter starts with a summary of the application of the mechanism and a detailed description of its various forms in common use. General equations of motion and force transmission are then given, leading on to a discussion of efficiency and performance in its various aspects. Tables of useful design data obtained from the relevant German standard or similar source are given in every chapter and the data are generally followed by a series of practical design examples.

The 388 illustrations are mainly in the form of line drawings or graphs and in their clarity provide an example, which many books on similar subjects could do well to follow.

No review of this book would be complete without mention of the very extensive list of literature references at the end of each chapter. These cover published work from many countries (though one is rather surprised to notice the absence of references from Iron Curtain countries!) and their extent will be appreciated, when one mentions that 266 distinct references follow the chapter on spur gears alone. The importance of this feature to research workers and students alike can hardly be over-emphasised.

The only drawback of this book to the average English-speaking reader is, of course, the language in which it is written and it is therefore to be hoped that an adequate translation will appear in the near future and thus make its contents available to a far wider readership. At its present price of approximately 50*s* 0*d* it is indeed good value and can be strongly recommended.

HERBERT L. WUNSCH

Making Better Use of Power in Factories

Economic Aspects of Fuel and Power in British Industry. *Manchester University Press.* (25*s*)

The most economical and convenient fuel for use in the various branches of industry is controversial in a great number of instances, although in some others there can be very little doubt. The papers given to the conference arranged by the Manchester Joint Research Council, together with the discussion which followed them, covers this question and are collected to form the contents of this book.

The subject must be continuously reviewed in the light of up-to-date facts and figures as the relative value of different heating agents in Great Britain has altered drastically during the last one or two decades with the rising price of coal, the greater availability of oil products and electricity, and the nationalisation and rationalisation of three out of four of the major fuel-supply industries. These matters, together with many other facets of this intriguing subject, are covered by the papers under the general headings of oil, coal, gas, nuclear power, electricity and future trends.

Although the subjects, as Lord Mills remarked in his opening address, are treated in an impressionistic manner there is a wealth of information and informed opinion, as all the authors of the papers, whose credentials appear on the contents page, are authorities on their subjects. In some cases the sales aspect of their approach is thinly veiled, but the reader who wishes to hear both sides has all the rival claims contained in the one volume, as well as the critical discussion which does not allow any extravagant claims to pass unchallenged. The discussion likewise, as in most cases where papers are read before meetings of professional people, contributes considerably to the coverage of the subject.

The treatment of the fossil fuels, oil and coal, each in two papers, is satisfying and, in both cases, proper emphasis is placed on the future economic availability of these commodities, backed up by figures presented in graphical and tabular form which are not difficult to follow. The paper on gas is more general, with some historical background, but with as much confidence as is shown in all the other papers that here is the fuel of the future. Nuclear power is treated fully with no attempt at detailed technology, but rather as an economic alternative to conventional fuels. The paper on electricity concentrates on the heat applications of this form of energy, with many more practical cases and tabular information than is contained in other papers, and the three on future trends have reference to the chemical and metallurgical industries and general fuel technology and are more thought provoking than attempting to cover the subjects. The last named, the paper by Dr. Macfarlane of the National Industrial Fuel Efficiency Service, allows him to do less than justice to this vital subject or his important work in furthering the economic use of fuel.

The book is, as the conference was undoubtedly intended to be, of as much interest and use to management as to those with more technical responsibilities, and indeed can be recommended to all who appreciate that the economics of fuel and power are of paramount importance in a modern industrial community.

A. C. HOLLIS

Electrical Efficiency in Industrial Plants. By EDWIN S. LINCOLN. *F. W. Dodge Corporation, New York.* ($9·50)

All modern production techniques depend on electricity for motive power. As the author points out, electricity is the most reliable, safe and versatile means of transmission ever devised. It follows, therefore, that in estimating factory overhead costs, electricity is the first liability. The author outlines in the broadest sense how these factors can be analysed and costs reduced by sound distribution planning, discriminating purchase of equipment (bearing in mind flexibility and future extension), efficient operation and effective maintenance.

Although the book is primarily intended to assist the electrical engineer in his endeavour to promote and maintain a high standard of plant efficiency, the author outlines the value of his work to consultants, company owners and plant managers in dealing with the ever increasing complexity of electrical efficiency problems in industry today.

The designing and planning of power systems is fully outlined and many recommendations are made in respect of power load per area of plant in several types of industrial installation. Considerabie mathematical detail is given, outlining power costs per unit produced.

The chapters concerning power factor correction examines a technical, yet most important, aspect of electrical plant efficiency and cost reduction. The author has spared no effort in diagrammatic outline and mathematical detail to make his point in emphasising the great importance of maintaining a high power factor in factory power systems. The writer feels that management in industry should fully understand the fundamental principles of alternating-current systems in order to have an adequate appreciation of the factors involved in the correction of power factor.

It is felt that the small industrial plant, which does not consider it economical to carry an electrical engineer on its staff is at a serious disadvantage and would be well advised to have this book prominently displayed so that all members of management could readily study the problems involved.

The chapters concerned with conducting and analysing electrical surveys contain a very valuable collection of information and data. Examples of demand surveys are outlined and the resulting improvement in efficiency and monetary saving are fully treated.

The author has attained his object; his vast knowledge of the subject and his endeavour to impart this knowledge has produced a book that will be an asset to the library of any plant electrical engineer or company executive.

E. FROST

Structures in Permanent Compression

Third Congress of the Fédération Internationale de la Précontrainte, Berlin, 1958. Edited by RALPH P. ANDREW. 2 volumes. *Fédération Internationale de la Precontrainte; Cement and Concrete Association, 52 Grosvenor Gardens, London, SW1.* (£13 *the set*)

Since 1946, when prestressed concrete made its first major impact on the world in the form of Freyssinet's bold experiment of the Marne bridges, it has become one of the most widely discussed methods of construction available to engineers. The recent announcement that the preferred method of construction for the new Medway bridge would require the use of prestressed concrete has made a great impact on structural engineers, particularly as it will be the world's longest span to be so constructed. Boldness in design seems to be a feature of prestressed concrete structures and the projected bridge typifies this.

The continuing and widening interest in prestressed concrete is demonstrated by the increasing numbers of papers presented to the four-yearly congresses of the Fédération Internationale de la Précontrainte—35 to the second congress and 62 to the third in 1958, now published in these volumes—as well as by the fact, brought out in one of the papers, that some 20 to 25 per cent of the total volume of reinforced concrete work in Great Britain now involves prestressing in one form or another. The proportion in the world is probably of a similar order. There is every reason to claim that prestressed concrete is a " growth industry,"

Continued on next page

and there are signs that the proportion will continue to increase.

As in many other fields of development, research into the properties of prestressed concrete and into the various constructional processes involved has tended to follow practice. As much research appears to be devoted to determining why structures behave as they do as to predicting how they will perform if built to a particular design.

The papers to the third congress and set out in the first volume are centred on three general themes: developments in design methods (session I); prestressing techniques with particular reference to grouting, anchorages and reduction of friction (session II); and the manufacture and site assembly of factory-made prestressed units (session III).

Although it was open to any author to submit a paper on a subject of his own choosing within the general classification, the delegates to the congress from Great Britain were asked to nominate authors who would present surveys of current practice and research throughout the country. This approach has had the effect of cutting down the number of papers from Great Britain to seven, of which three are presented as British National Reports. This system could, with advantage, be more widely applied, for some individual papers can hardly justify their presence in a volume such as this.

It is always the case that papers on design methods command a high proportion of the available time at such a congress as this—problems of shear, compression, frictional and torsional strengths occupy the minds of many research workers. But it can hardly have been suspected, in the early days of prestressed concrete, that the technique of cable grouting to prevent corrosion and to develop full bond between prestressing tendons and concrete can have presented such problems as some papers reveal. It is also unlikely to have been suspected that the action of frost on grout in cable ducts might have serious consequences. A further group of papers discuss the friction developed between a cable and its surrounding duct—one of the imponderables of prestressed concrete—and the means whereby it might be reduced.

The papers presented in session III are probably of the widest general interest and quote numerous examples of the way in which factory-made units are produced for all types of structures.

It is difficult to single out those papers which are of outstanding quality but some dozen or so —7, 21, 22 and 23 in session I; 1, 3 and 6 in session II; and 1, 4, 9 and 10 in session III—are most likely to reward careful study. Contributions from the Soviet Union rank high in technical interest but much of the information published has appeared previously. This, of course, applies to a large part of the congress proceedings.

Of the total number of papers presented, 26 are in English, 20 in German, 13 in French and 3 in Spanish. The non-linguist or reader who finds it difficult to understand technical papers in languages other than his own can fall back on a comprehensive "General Report" on each of the three sessions, printed in full in the four congress languages. Those papers which appear to be of special interest can doubtless be made available in the preferred language, though the publishers do not offer this service.

The editor has taken the unusual step of printing the whole of the discussions at the congress in a separate volume. This simplifies cross reference between paper and discussions and is a practice which might be further extended. It is a feature of the discussions at such a congress that a number of "hobby horses" are ridden; doubtless this congress was no exception, but the editor has taken the necessary steps to eliminate over zealous claims for pet theories or products.

The presentation and printing of the volumes follow the high tradition of the Cement and Concrete Association's publications and they form a useful addition to the technical library.

J. M. FISHER

Training Stirs Embryonic Nations

The Belgian Congo. By RUTH SLADE. *Oxford University Press.* (5*s*)

There is a grim irony about this little book. It has been written as a brief but informed guide to the breakdown of Belgian paternalism in the Congo since the war. It tells how the alliance between the State, the Roman Catholic church and the big companies, on which that paternalism was based, broke down in recent years in response to pressure from pan-Africanism from without and political schism from within, the latter taking the form of a split among the Belgian political parties at home about colonial policy. The book pleads for speedy political progress in the Congo for the sake of everyone concerned. The irony is that the speed generated at Brussels was not fast enough to control events at Leopoldville. The book, like the Belgians, has been overtaken by events. Even so the book's manuscript is only now a year old.

It remains, however, a useful guide to recent political events leading up to the turbulent birth of Congo's independence. In only a limited sense, as regards the question of salaries and the standard of living, is it concerned with economic matters. Wisely, as events now show, it has hazarded no guesses about the future.

Within this slender volume (prepared on behalf of the Institute of Race Relations with aid, connected with a wider project, from the Rockefeller Foundation) is the age-old refutation in a modern context of the adage that whatever is best administered is best. The French and the British have learned it in a modern context. The Belgians failed to do so. Who is left to learn? The Portuguese? The United States with its colour problems? The South Africans?

It does not pay in this country to adopt a superior attitude about the Belgian problem in the Congo. As this booklet shows, the tragedy in the Belgian Congo is in a sense a breakdown of a carefully managed plural society. Congolese discontent was fomented by the inability of the emergent, middle-class negro to earn a salary and gain a social position equal to the white man. The new African clerk and technician, like the French middle class of the late eighteenth century, demanded equality and in the end hated the Belgian for withholding it.

This is therefore a tract for our times. Once the machines and technicians arrive, the local population is politically and socially on the move. Today it is the Congo which has beaten the carefully worded memoranda and timetables of the administrators. Tomorrow it could be the Rhodesias, Kenya or South Africa. This booklet is worth reading in today's context of race problems in Africa. It shows that the way to hell is paved with good intentions. The more who see that point, the better.

G. E. TEWSON

New Books

Production Control. By NYLES V. REINFELD. *Prentice-Hall, Englewood Cliffs, New Jersey and London.* (54*s*)

Mr. Reinfeld has drawn on discussions with more than 1,500 production control men for this handbook. Although methods that have worked exceptionally well for some companies may not work at all for another, the author maintains that "the principles and perspective are the same for everyone."

Machinery's Annual Buyers' Guide, 1960. 31st edition. *Machinery Publishing Company.* (12*s* 6*d*)

A directory for buyers of engineering shop equipment and materials, giving the names, addresses and products of some 4,500 suppliers. The Russian/English technical glossary of some 1,000 terms is a new feature.

Inflation and Society. By GRAHAM HUTTON. *Allen and Unwin.* (15*s*)

The chief concern of the author is to make clear in non-technical terms what inflation does, both to society and to its individual elements, to weaken and hamper democracy.

Basic Principles of Nuclear Science and Reactors. By ALAN M. JACOBS, DONALD E. KLINE and FORREST J. REMICK. *Van Nostrand Company, Princeton, New Jersey and London.* (49*s*)

Literature on nuclear reactors and reactor radiations has tended to resolve into two groups: rigorous derivations of the necessary theory, and qualitative descriptions of the resulting systems and their use. This present book attempts to bridge the gap between these two patterns.

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Transmissions

Timing Belts. CROFTS (ENGINEERS) LTD., Bradford 3. "Powergrip" timing belt drives; ½ in pitch for powers up to 64 h.p. at 6,000 r.p.m. Range of sizes of belts and pulleys given in 30 page catalogue, together with selection notes. Publication 359.

Variable Speed Units. B. & F. CARTER AND CO. LTD., Albion Works, Bolton. "Ribble" infinitely variable speed units from ½ to 2¾ h.p. at 1,440 r.p.m. input speed. Publication P2.

Gears. J. THOMPSON AND SON (GEARS) LTD., Swan Gear Works, New Addington, Croydon, Surrey. Spur, spiral bevel and worm gears in the smaller sizes. Also complete boxes. Leaflet.

Hydraulic Couplings. CROFTS (ENGINEERS) LTD., Bradford 3. Hydraulic couplings and pulley drives in the power range from ¼ to 300 h.p. and speeds from 475 to 1,780 r.p.m. Models available in range of bore sizes. Folder.

Chain Drives. BORG-WARNER LTD., Letchworth, Herts. Morse chains for industrial drives; 50-page booklet gives all design details as well as range of sizes; also chain-type couplings. Catalogue 959.

Rope Drives. CROFTS (ENGINEERS) LTD., Bradford 3, Yorkshire. "Ultivee" rope drives with high power ratings said to reduce number of belts required by 40 per cent. Three sizes cover powers up to 8 h.p. at 500 r.p.m. or up to 52 h.p. at 6,000 r.p.m. Publication 6026 gives details and tables.

The Reviewers

Dr. D. R. Chick, is group leader of the Nuclear Sciences Group at the AEI Fundamental Research Laboratory, Aldermaston Court. Since 1951 part of this group has been responsible for the fusion research programme leading to the present series of experiments using Sceptre.

Mr. H. L. Wunsch, M.Eng., A.M.I.Mech.E., is principal scientific officer in the Mechanisms, Metrology and Noise Control Division at National Engineering Laboratory of DSIR at East Kilbride.

Mr. A. C. Hollis is a member of the Ford Motor Company's power operations department.

Mr. E. Frost is superintendent of the electrical maintenance department in the Ford Motor Company Limited at Dagenham.

Mr. J. McNeal Fisher, B.Sc., M.I.C.E., M.I.H.E., is technical adviser at the Research and Development Centre of John Laing and Son Limited. He has been the joint author of several papers on road construction presented to the Institution of Civil Engineers and to other bodies.

Mr. G. E. Tewson, M.A., is a partner in the firm of O. W. Roskill Industrial Consultants.

Marketing

Rolls-Royce Engines for Swedish Railways

FIFTY new single-engine shunting locomotives to be built for the Swedish State Railways by KALMAR VERKSTADS AB are to be equipped with ROLLS-ROYCE diesel engines and torque converters. Rolls-Royce obtained the order against intense competition from American and European manufacturers.

The engines (Rolls-Royce C8TFL) are of the eight cylinder turbo-charged type. The torque converters will incorporate a free-wheel which will allow the locomotives to coast.

British Diesel Engines for German Fork Lift Trucks

PERKINS ENGINES, of Peterborough, are to provide four cylinder diesel engines worth almost £150,000 for German fork lift trucks.

The engine contract has been placed by RUHR INTRANS HUBSTAPLER, of Mulheim. The engines, for which Perkins announced a £35,000 order earlier this year, are the Perkins Four 203 diesel, rated at 55 b.h.p. at 2,200 r.p.m.

Pyrene Enters Breathing Apparatus Field

PYRENE, the fire protection and safety equipment company, who also produce motor vehicle bumpers in quantity, have bought S. F. ROBERTS, the Brentford, Middlesex, makers of breathing apparatus, civil defence equipment and a variety of industrial protection gear.

Pyrene, through its subsidiary, PYRENE-PANORAMA, already makes an extensive range of industrial protection equipment, including goggles, eye shields, face shields and helmets. Among other products, the S. F. Roberts acquisition brings Pyrene into the field of breathing apparatus.

The Pyrene chairman and managing director assumes the chairmanship of the company, now to be named S. F. ROBERTS (1960) Limited.

New ICI Plastics Licence Agreement

IMPERIAL CHEMICAL INDUSTRIES have signed a licence agreement with MONTECATINI, the Italian concern, for the manufacture from polypropylene, a raw material of the plastics industry, of staple fibres, filament yarns and textile monofilaments. Montecatini are themselves producing in Italy clothing, carpets, household textile and ropes using polypropylene fibre under the "Meraklon" trade name.

ICI and the SHELL Company already hold licences from the Italian firm for the production of polypropylene as a plastic. ICI will be making 10,000 tons a year of the polymer from their Wilton plant later this year. Shell will be bringing on stream their plant at Carrington next year with a 30,000 ton annual capacity which includes other plastics raw materials.

Great Britain Day at Bulgarian Trade Fair

Only four British firms turned up at the Bulgarian International Trade Fair, held at Plovdiv, in 1958. This year the Plovdiv Fair opened with 42 British firms using 570 sq. m in a pavilion and about the same space outdoors.

The United Kingdom firms vary from the British Band Instrument Company and the British Crane Company to the Ford Motor Company tractor division and the Scottish Machine Tool Corporation, of Glasgow.

British trade with Bulgaria has been growing appreciably over the last two years.

Bulgarian exports to Britain almost doubled in 1958 and went up by a third last year. In 1959 British exports to Bulgaria were worth £1,903,942—six times that of the previous year. The first half year export figure for 1960 is £1,899,300.

A large part of the work behind these increases has been done by LAMET TRADING Limited of London. The first requirement for increasing trade between the two countries was for improved understanding of each other's needs. Bulgarian agriculture produces to high standards, but it was necessary for Lamet to send people out to Bulgaria to instruct packing stations, factories and slaughter houses in the packing and standards required by the United Kingdom market.

At the same time the company investigated the needs on the Bulgarian side. The majority of Bulgarian buyers are German or Austrian trained, working to Continental standards. British manufacturers had to be made aware of the importance in the Bulgarian market of German and other Continental practices. Since few of the Bulgarian buyers and users are able to understand English, language difficulties arose.

The services of translators were brought in by Lamet.

The UK Government is for the first time sponsoring the British exhibit at Plovdiv. Steel, textiles, cranes, contractors' plant, electronic communication and agricultural equipment is all being shown. From the transport interests Land Rovers, cars, buses, tractors, and locomotives are being shown.

The Plovdiv Fair runs from 18 September to 2 October and will officially celebrate 29 September as Great Britain Day.

Rising Foreign Earnings of UK Contractors

United Kingdom contracting companies are carrying out a rising volume of overseas work, particularly in Australia and Canada.

In the year up to March, 1960, the value of work done, of contracts obtained and of work outstanding all increased—the new contracts by the highest amount.

The Board of Trade's *Journal* reports that contracts obtained during the year were worth £131 million (£40 million in the dollar area) against £114 million in the previous twelve months. The value of work done during the year rose from £120 million to £124 million (£33 million in the dollar sector).

Work still to be done rose from £20 million on dollar contracts to £29 million. The total amount of work outstanding for overseas clients has increased from £124 million to £133 million.

The construction work completed abroad in this twelve month period is the highest since the Ministry of Works began keeping these figures.

High Land Costs Bring High Density Approval

The increasingly high cost of land continues to produce effects in Whitehall. Mr. Henry Brooke, the Minister of Housing, has consented to development schemes involving high densities at Henley-on-Thames and Wanstead. Both schemes involve high flats.

The Henley decision by the Minister was given on appeal by TOWNMAKER LIMITED, who had been refused permission by the Oxfordshire County Council for the building, on almost seven acres, of houses, maisonettes, studios, garages, and a 25 storey tower block of flats. The Wanstead scheme had been sought by Wanstead and Woodford Borough Council for blocks of flats of 8 and 11 storeys giving 102 homes, with 24 garages and parking space.

Public controversy followed the announcement of the Henley scheme. Oxfordshire Council refused permission, although recognising a high standard of design. The Council believed that a tower of more than seven storeys would be out of scale and out of character with Henley, a small residential town in the Thames valley.

Little Conflict

In his report to Mr. Brooke, a Ministry inspector said that as the appeal site was topographically separate from the town and well screened by trees, conflict between old and new scarcely arose.

The Minister's permission for the Henley development carries a condition that the tower block must not be more than 15 storeys high. The original proposals had envisaged a tower block of 25 storeys. The Ministry Inspector had considered that even with the reduced height of 18 storeys suggested by Townmaker the tower would form "an unwarranted and isolated" intrusion into the landscape which would be out of scale and character with the old town centre. He recommended that the appeal be allowed but that the proposed block of flats be restricted to less than 70 feet.

Mr. Brooke, giving his decision, agreed with his inspector's general recommendation but did not wholly accept the criticism of the proposed tower block. He did not regard a block of flats as objectionable merely because it broke the skyline. A block of 12 to 15 storeys, rather than one of 18 to 25, would be reasonable in relation to the long, low terraces on the site. Mr. Brooke did not think such a block would overpower or dominate Henley.

If the tower were elgantly designed he thought it would add to and not detract from the landscape.

Mr. Brooke again varied the recommendation of his inspector on the Wanstead scheme. The inspector had proposed a restriction of the tall blocks to 8 and 6 storeys. Mr. Brooke thought that the difference in effect on the surroundings of 8 and 6 storey blocks would not be significant from that of 11 and 8 storeys.

The letter giving the Wanstead decision says: "The Minister regards it as of growing importance that advantage should be taken of redevelopment schemes to secure the fullest use, compatible with good living conditions, of land in urban areas in order to relieve pressure for development on land outside the towns and to help to meet the demand for dwellings from an increasing number of separate families."

Russian Aid for Cyprus Foreshadowed

The recent ten-day visit to Cyprus by Mr. Sergeyev, the Soviet Ambassador in Greece, has given rise to speculation on a future offer of Soviet aid to the new island republic.

On leaving Nicosia to return to Athens Mr. Sergeyev looked forward to the Russian Embassy being in operation in the island within a month.

With the build-up of the island's economy, for which there has already been arranged a £14 million aid scheme from the United Kingdom, any aid offer that may be made by the Soviet Union is likely to be received with enthusiasm by at least some Cypriots.

British Industrial Films in Prague

The now renowned BRITISH IRON AND STEEL FEDERATION film Hazard, on safety in industry, is one of eight industrial films from the United Kingdom being shown at the International Scientific Film Association meeting in Prague, Czechoslovakia.

With Hazard will be seen the Clydeside shipbuilding film representing British industrial skills, Seaward the Great Ships. THE SHELL INTERNATIONAL PETROLEUM film made for the Royal Society's tercentenary celebrations, Light in Nature, is also being shown.

The March Fritillary Butterfly was made by Mr. Gerald Weinbren of the Bristol Engine Company in his spare time. Four Point Conics, by Mr. Trevor Fletcher deals with his mathematical work at the Sir John Cass Institute.

Oil States Gather in Baghdad Talks

Delegations from Middle Eastern oil states and Venezuela, producing some 40 per cent of the world's oil output, are discussing levels of oil production and prices in Baghdad. Iraq, Iran, Saudi Arabia, Kuwait, Qatar and Venezuela are represented.

It is understood that the principal aim of the conference is to draw up and adopt a joint policy for the nations dependent upon oil revenues. The delegations will plainly have in mind the recent reductions by the big oil companies in the posted prices of crude oil.

Decisions taken by the conference on levels of production from their resources are likely to be at least as important as representations on prices that may be made to the oil companies.

Aircraft Electronics are Doubling Up

Greater demands will be put on the reliability of aircraft electronics. Often the answer is duplication of circuits. Alternatively "dormant fail" design can be used.

THE main interest at the Farnborough Show this year was the static exhibition, where equipment for aircraft not yet in the air was to be seen. It was apparent that much thought is being devoted to the problems posed by the next generation of civil aircraft and the congested airways in which they will fly. So heavily will future flying depend on electronic aids that new concepts of electronic reliability are having to be thought out.

In recent years, development of electronic equipment of greater reliability has been the keynote of many manufacturers' programmes. Transistors have replaced valves in many applications, more attention has been paid to mounting and cooling techniques, soldered connections have been improved or removed altogether, and component layouts have been designed for maximum accessibility and ease of servicing. But this is not enough. Now attention is being directed to the reliability of complete systems. This involves design work additional to that involved in making the individual units of the system more reliable.

The impetus for the expanding programme of system design has come from the requirement for automatic landing. Since the virtue of automatic landing is that it enables aircraft to land in conditions in which manual landing is impossible, it is vital that the automatic landing system adopted should not fail at such times and present the pilot with an impossible task. Since most electronic units have a finite probability of failure, it is important to ensure that the system incorporating the units should safeguard itself against this eventuality.

"BLACK BOXES"

As far as the individual electronic black boxes are concerned, it is interesting to compare the situation in automatic aircraft systems with those in the submerged repeater amplifiers of the transatlantic cable. In both situations the demand for reliability is paramount. But whereas the submerged repeater is designed to operate for 15 years or so under static conditions, the aircraft electronic units operate under conditions of altitude and vibration, and for shorter periods. The electronic equipment in aircraft is more complex, and is subject to stringent space and weight restrictions. In addition, whereas submerged repeaters can be built up of simple and well-tried valves and components, aircraft circuits generally require more recently developed components. And cable repeaters have been improving over a good many years, whereas many electronic aids in aircraft are a relatively recent development.

At present it seems unlikely that aircraft practice will follow underwater-repeater techniques to the extent of gold plating of circuits and assembly under ultra-clean conditions. But the rigorous selection of components for high reliability, and extensive quality control and testing, are procedures that will probably be adopted from cable practice. Also, the technique of duplicating certain critical circuits will be followed.

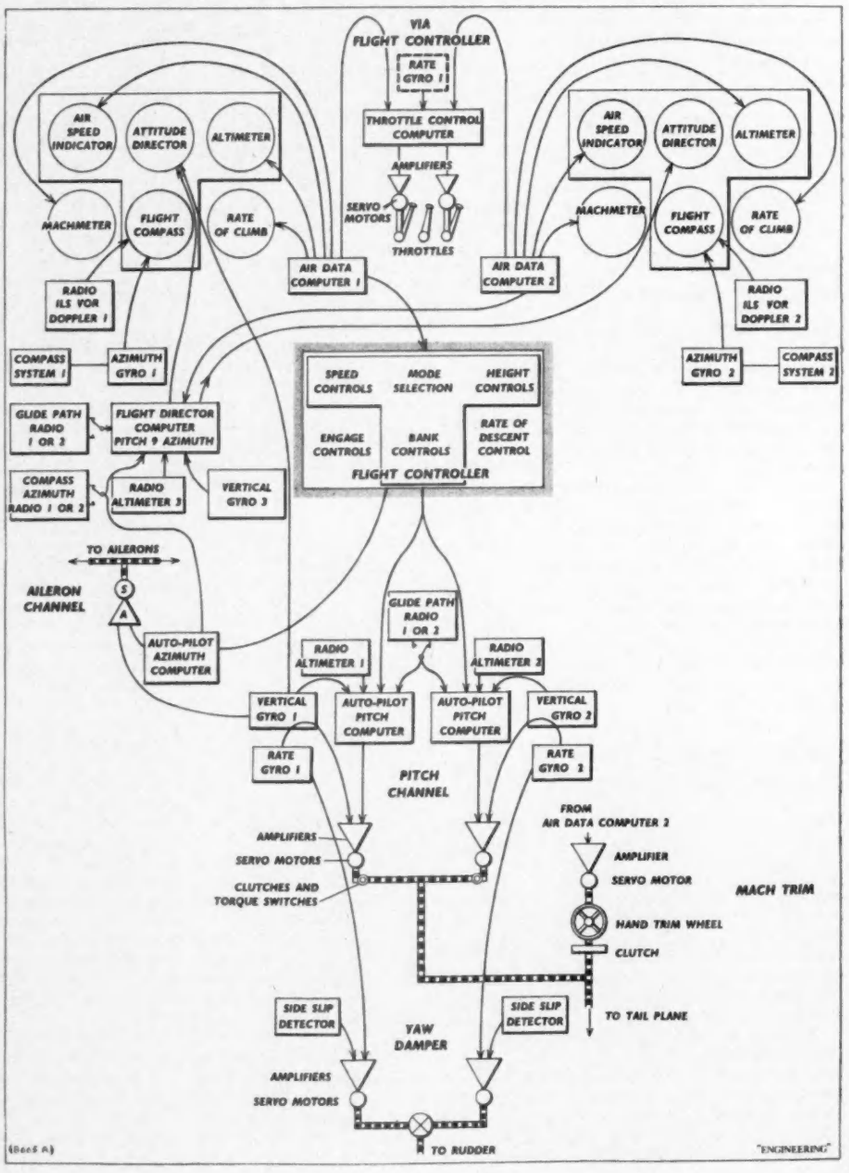
The investigation of these and other reliability problems is being carried out by Elliott Brothers (London) Limited, in design studies for the VC 10. The approach they are concentrating on differs from that followed by Smiths Aviation Division in their work (described below) on the DH 121, in that duplication, with subsequent triplication, of the larger part of the electronic control system is not envisaged. Rather than have three complete electronic units in parallel, Elliotts are considering a single unit in which failure of certain components would not lead to maloperation of the unit as a whole. That is, a "dormant fail," or fail-safe, system would be produced, with failure of a component being indicated but not to the extent of the unit going dangerously outside its performance limits.

Certain components such as microswitches and relays would be duplicated, where a single component would not in itself meet the reliability criterion for the unit and is of this "on-off" nature. But in other cases reliability would be introduced by designing the circuit in such a way that should part of it fail the remainder could handle the increased load imposed on it and still function correctly. A simple example is provided by, say, a critical resistor: by splitting this up into a number of resistors in series and parallel, an individual resistor could fail without the total resistance in circuit departing from the value tolerable.

Another technique for improved reliability is the use of high integrity circuits. Certain aircraft control circuits operated by relays have given trouble in the past due to the leakage of voltages from adjacent cables into the circuit, producing spurious operation of the relays and, consequently, the controls. To overcome this, the engage circuits in the auto-pilot (which involve cables running up the pilot's control column, in company with many other circuits) will operate from a power supply contained within the autopilot, being fed through isolation transformers. The supply voltage will be chosen so that it is quite different from any other in the aircraft as regards voltage, isolation, and source impedance. Paralleling of the relays in the engage circuits (and serialisation in the disengage circuits) would be used to bring the relays themselves within the reliability requirements of the unit as a whole.

The multiplex philosophy for system reliability was exhibited by Smiths Aviation Division. A multiplex channel comprises two or more sensibly independent but similar sub-channels.

Extensive duplication is envisaged in the Smiths automatic system to obtain reliability.



Each sub-channel is capable of gaining its objective alone, and could thus be used in a conventional simplex or single-channel autopilot. In a multiplex channel they are used collectively to provide continuous redundancy.

The Smiths SEP5 autopilot and associated equipment on show provided full auto-flare control and could be adapted for Autoland. It has been selected for the DH 121 and will initially obtain reliability by duplication of control system components which have critical safety requirements. The chain of units from the flying computer to the control surfaces, for example, is largely duplicated, ending with duplicate servo motors with duplicate power supplies. Both channels are in continuous operation and the servo outputs are continuously compared for significant difference. If this should become apparent, total disengagement of both sub-channels occurs.

The system is designed to be capable of later modification to tiplex level; that is, three separate channels operating continuously. Deviation of the output of any one channel in comparison with the outputs of the other two would cause the deviating channel to be switched out and automatic operation to continue on a duplex level. By providing continuous redundancy in this way it is not necessary to change over to an alternative system that has not been in full operation.

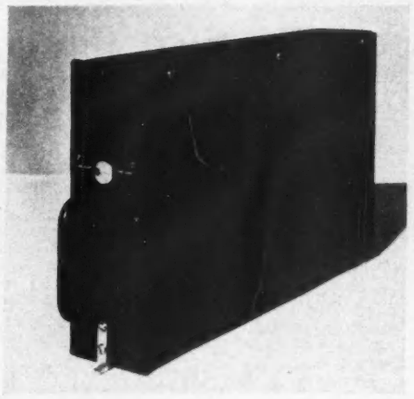
Incorporation of the duplex philosophy was noticeable in the new range of airborne navigation and approach guidance equipment (type AD260) exhibited by Marconi's Wireless and Telegraph Company Limited. These units will be available on a production basis by the time the VC 10 comes into service in 1963, and considerable attention has been paid to the demands for reliability, About half of the new units are made up of sealed modules and a high degree of transistorisation has been carried out. In the Glide Slope Receiver (type 6404), for example, separate sealed cans containing a dry inert gas house the transistorised r.f. amplifier, r.f. oscillator, i.f. amplifier, and filter sections. For duplex systems, space has been left in the container that houses the complete receiver for insertion of a duplicate filter unit. It is this sub-unit which is duplicated because it is the one with a critical safety requirement: maloperation could result in a misleading direction to the flight control computer.

AUTOMATIC NOISE ADJUSTMENT

The complete v.h.f. navigation and approach guidance equipment incorporates a v.h.f. receiver (type 6401), a navigation unit (type 6402), a marker receiver (type 6403), and the glide slope receiver. All units are completely transistorised. The 6401 receiver covers the band 108·0 to 135·95 Mc/s, providing 560 channels. It is a multiple superhetrodyne with a final intermediate frequency of 500 kc/s. An interesting feature is the incorporation of an automatic squelch control. Instead of the level at which the squelch control operates having to be set manually for the noise levels around different airports, a circuit is incorporated which relates the squelch level to the prevailing signal-to-noise ratio.

The navigation unit operates in conjunction with the receiver to provide instrumentation outputs for VOR and ILS localiser. The resolver circuits in the omni-bearing selector operate at 400 c/s, simplifying the zeroing procedure and making the system compatible with most flight director systems. An improved form of flag warning system not only gives warning of loss of any of the tone signals used for localiser and VOR operation but also indicates failure of the VOR servo, or loss of the 400 c/s power.

Sealed modules are used in the navigation unit, the marker receiver, and the glide slope receiver. The modules have small square sections of rigid construction, to avoid resonances, and have a relatively large area. By arranging them vertically, full advantage can be taken of central cooling systems without danger of contamination by dirt. An insulated board at one end of the module's chassis forms a sealing plate for the unit and carries 12 screw-threaded bushes for



Transistors, sealed modules, and provision for duplication of critical modules, are features of the Marconi navigational equipment for the next generation of civil aircraft.

connection of external wiring. Only about five external connections are made to the unit, and the remainder of the bushes are used for bringing out test points. Should a fault appear in a unit the separate modules can be completely tested without being unsealed. When the particular module in which the fault lies has been identified, it can be unsealed, repaired and resealed very simply without the use of specialised apparatus.

Duplication for reliability was also in evidence on the stand of Ecko Electronics Limited. Airborne weather radar is now mandatory in some countries and is likely to become recognised universally as essential equipment in many types of aircraft. Following the philosophy of duplicating essential services, therefore, Ekco have produced a duplicate version of their type E190 3 cm weather radar. The same 24 in diameter scanning dish is retained, with velocity stabilisation, and the transmitter/receiver and controller/indicator unis have been duplicated.

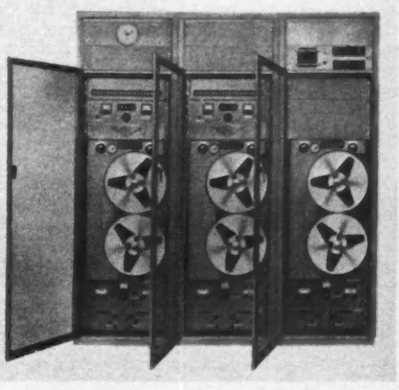
The aerial scanning dish covers $\pm 90°$ in azimuth at 20 cycles per minute, line-of-sight stabilisation being provided by a transistor/magnetic-amplifier servo system. The high scanning rate contributes greatly to the clarity of the display during turns, but calls for high performance in the stabilisation system. This is normally made difficult by the fact that in order to obtain a smooth servo response free from dead spots and overshoot, a servo system with tachometric velocity feedback is required, the velocity feedback being sufficient to swamp likely variation in scanner friction-loading resulting from wear and temperature variations. In the past it has not been possible to do this in full, as a substantial velocity lag results, which can only be reduced by using either very high servo powers or by reducing amplifier gain and velocity feedback simultaneously. The latter expedient gives a smaller lag but reduced stabilisation.

The present design of scanner system avoids this difficulty by the use of a velocity computer that enables the servo amplifier to be fed with two error signals, the first being the normal position error, the second being a velocity demand signal computed from the scanner tilt and pitch demand, which produces cancellation of the velocity feedback voltage, thus removing velocity lag. With this system, stabilisation errors due to servo lag are held to within less than 1° over the whole range of roll and pitch demand. The stabilisation system is effective over the range $\pm 25°$ centred at zero tilt angle.

In the E190 single-channel system, the servo amplifier is mounted in the scanner and is split into two units. The power section uses magnetic amplifiers and these are mounted as counterweights at the rear of the dish. The pre-amplifier and mixing circuit uses transistors throughout and is mounted in a hermetically sealed repairable can inside the spine of the dish drive mechanism.

In the double-channel system, the scanner control circuits have not been duplicated but have been transferred to the back of the duplex receiver/transmitter unit, on to the chassis containing the interlocks for transferring the channels. The magnetic transducers have not been duplicated and have been retained as counterweights. Twin synchros have, however, been put in to serve the independent time bases of the display units. Even should a fault develop in one transmitter/receiver and also in one indicator unit, the remaining units will continue to operate satisfactorily, providing full weather radar. Provision has also been made for connection to dual power supplies and dual stabilisation references.

Tape recorder for airport communications: continuously monitored on up to 20 channels. Automatic switching to a stand-by channel or stand-by equipment follows detection of a fault.



RELIABLE RECORDING

Demands of reliability have to be met by ground equipment too. A particular example is provided by the recording equipment used to log air traffic control and approach guidance communications between ground and air. Since such records would be conclusive evidence in most cases where they are used to settle a dispute or to guide an inquiry, it is important that they can be relied on implicitly.

The Series III multichannel recording equipment displayed by Thermionic Products (Electronics) Limited was designed with this requirement in mind. The system is available for a number of tape sizes, accommodating up to 20 tracks on 1 in tape. Each channel is monitored continuously throughout the operation of the recorder and if failure on one channel is detected the signal on that channel is transferred to a standby channel. When two channels are found to have failed the whole set of signals is transferred to a standby recorder.

Monitoring is carried out by injecting a 3·5 kc/s signal on to the tape by the recorder head and detecting it on each channel by monitor heads feeding individual amplifiers. Transistors are used throughout the system.

The three-bay version of the equipment, intended for large international airports, provides 36 hour continuous recording using long play tape or 24 hours using standard tape. Time signals are recorded on one channel in the form of four-digit morse code signals every minute. These are derived from a clock and coding unit which houses a 10 kc/s crystal oscillator; the output of this is divided down to produce 50 c/s to drive a synchronous clock motor. The latter provides a conventional clock display and also drives a series of printed wiring discs that code the output of a 1,000 c/s oscillator to supply the correct morse time signal.

On the tape deck itself, one of the idler pulleys operates a velocity switch to give warning of tape stoppage or slowing. Accidental or unauthorised erasure of records is prevented by locked doors fitted over important controls. For the same purpose, no erase feature has been built into the equipment itself.

Simca Aronde Engine with Five Bearings

The new five-bearing engine introduced by Simca for their Aronde and Ariane cars has been launched with an impressive demonstration of long-distance endurance at the long-deserted Miramas track, 44 miles from Marseilles. Driving day and night for 80 days a team of ten drivers covered 200,000 km. (124,300 miles) at an average speed of 65·1 m.p.h. The test was observed by A.C.F. officials and claims are being put in for homologation of 41 world records on a time basis and 16 on a distance basis, regardless of engine size together with an equivalent number of records in Class F.

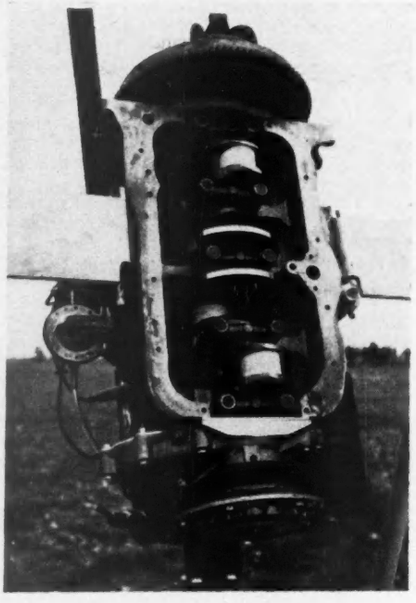
The engine itself is a good example of the expedients which engineers are forced to adopt for financial and fiscal reasons. Starting with the pre-war Fiat 1100 built under licence in France, it was developed by Simca into a unit of 1,290 c.c. (74 × 75 mm.) giving 50·5 b.h.p. SAE at 4,900 r.p.m. on a 7·2 to 1 compression ratio, as used in the Aronde and Ariane or 59 b.h.p. at 5,000 r.p.m. on an 8·2 to 1 compression ratio as used in the Aronde Montlhery and the sports coupe.

In the Aronde, which was designed for it, the engine performed well, but it was barely adequate for the big-bodied 2,420 lb Ariane economy model using the body and road gear previously propelled by an ex-Ford 2,300 c.c. V8.

For tooling reasons it was essential to conserve the existing cylinder spacing. Moreoever, an increase in cylinder capacity to 1½ litres would have faced French buyers with an increase in annual tax and a rise of anything between £5 and £14 in their insurance premiums.

The arguments were therefore strong for an increase in specific output, but the lower end of the engine was not suitable. Increases in bore had already made it necessary to offset the connecting rods in relation to the crankpins and main bearing area was not generous. Simca therefore adopted the expensive solution of a five-bearing engine. First, third and fifth bearings are 44 mm diameter and 16 mm wide. Second and fourth bearings are slightly narrower, but total main bearing area is increased by 30 per cent. The webs carrying the new second and fourth bearings do not extend right across the crankcase as clearance was required for the dipstick and for the distributor drive. The connecting rods are now centralised on the crankpins but the specific loading made steel-backed copper-lead-indium shells necessary. However, with the adoption of a fan pulley containing a centrifugal filter as on Fiat engines, there has been no need to nitride the shaft and the interval between oil changes has been increased from 1,500 miles to 2,500 miles. Vacuum control of advance is now provided on the distributor.

A new, reinforced cylinder head raised the compression to 8·5 to 1, giving 61 b.h.p. SAE at 5,200 r.p.m. with max. gross torque of 73·6 lb-ft at 2,600 r.p.m. for the Ariane and the top-priced Aronde models. On the lower priced models in the Aronde series the compression ratio is 7·5 to 1 and the output 51 b.h.p. SAE at 4,900 r.p.m. Power for the Ariane has thus gone up from 50·5 to 61 b.h.p. with complete reliability.



A 5-bearing crankshaft, and fan pulley with centrifugal oil filter are used on the new engine for the Simca "Aronde" and "Ariane."

Corrosion of Aluminium Heads on Cast Iron Engines

The high strength to weight ratio and thermal conductivity of aluminium makes it very suitable for use as a constructional material for internal combustion engines. The high conductivity gives efficient heat transfer, which can result in longer valve life and lower octane number requirements, and the material can be more readily cast and machined than iron alloys. At present it is possible to foresee varying degrees of use of aluminium in vehicle engines: an iron cylinder block and an aluminium head; an aluminium block and an iron head; an aluminium block and head with wet iron sleeves; and an aluminium block and head with dry sleeves or wet aluminium sleeves. The question to be answered before aluminium and iron are mixed in production car engines is whether corrosion is going to present difficulties.

An answer is provided in a paper "Corrosion Resistance of Aluminium Automobile Engine Components," by A. M. Montgomery, Alcoa Research Laboratories, Aluminium Company of America, Cleveland. It was read during the National Automobile Week held by the Society of Automotive Engineers, at Detroit.

Studies were concentrated on cast alloy parts in direct contact with the coolant, as Alcoa did not anticipate serious corrosion in other parts of the engine. Over 200 cyclic engine or road tests were performed on aluminium cylinder heads mounted mostly on V-8 engines with cast iron blocks. Split radiators were used to compare two different coolant solutions.

ELECTROLYTIC BEHAVIOUR

The composite aluminium-iron engine presents the major corrosion problem owing to the possibility of galvanic corrosion. The solution potentials between cast iron and several aluminium casting alloys when in contact with a hot anti-freeze solution is shown in the table, and it will be seen that selection of the correct alloy considerably reduces the likelihood of corrosion. Being the more electronegative, it is the aluminium that is removed during the galvanic corrosion process and it was possible to compare the resistances of the various alloys to corrosion by measuring the depth of corrosion pits. Of the alloys listed 319-F is the most compatible with cast iron because of its low solution potential difference.

It is the copper content of the 319 alloy that makes for the more positive solution potential, while the zinc content of the C612 renders this alloy more negative. To be effective the copper must be in solid solution, so that as-cast 319-F alloy is to be preferred to the aged 319-T5 condition, as in the latter case the copper is largely precipitated from solid solution.

The most severe corrosion encountered was at the coolant ports, close to the cast iron block. Here the coolant flow had by its sweeping action eroded the protective film, which develops on aluminium, and so accelerated corrosion. The use of a gasket with metering ports at the interface can prevent direct impingement of the coolant stream, or alternatively, larger ports can be incorporated in the aluminium than in the iron.

Gasket materials used should not absorb water since poultice-type corrosion may otherwise occur. Under these circumstances, aluminium in contact with absorbed water in the gaskets reacts with dissolved oxygen and locally depletes it. At an adjacent free surface the water will be saturated and a difference in solution potential arises which can accelerate corrosion. Steel-asbestos and even copper make successful head gaskets.

Brass temperature wells, copper or steel gaskets, brass thermostats, and brass radiators could all conceivably act as cathodic elements in a similar manner to iron, but in practice they do not. This is because solution potential difference is not the sole controlling factor in galvanic corrosion. In the case of the first three possibilities mentioned, the anode to cathode area ratio is the controlling factor. Because the aluminium area is much larger than the heavy metal area, the latter is polarised to the same potential as the aluminium and relatively little corrosion current flows. In the case of the brass radiator, the indications are that it does not contribute directly to galvanic corrosion of the aluminium, probably because of the long path in the electrolyte over which the solution potential differences have to operate.

Corrosion of Aluminium Alloys in Test Engines

Alloy	Solution* potential difference (volts)	Composition				Depth of corrosion (in)
		Cu	Si	Mg	Zn	
319-F	0·060	3·5	6·3			0·020
356-T6	0·170		7·0	0·3		0·034
C612	0·300	0·5		0·35	6·5	0·120

* Determined in a solution of two volumes of tap water (high chloride—273 ppm) plus one volume of ethylen glycol, at 165° F.

COOLANT TESTING

In the road tests of the composite engines a wide variety of coolant compositions was investigated to determine their effect on corrosion at the coolant ports mentioned above. All types of water proved to be relatively harmless, but chlorinated water mixed with proprietary glycol or methanol produced an appreciable attack—0·040 in and 0·060 in respectively. It is believed that this was a result of inhibitors of iron corrosion in the anti-freeze solutions: these change the polarisation characteristics of the system in a way that promotes aluminium corrosion. A satisfactorily inhibited coolant was provided by the introduction of 1 per cent of a naphthenic-base soluble oil. Chromates, dichromates, and nitrites, should be avoided in composite engines.

If the alloy and gasket designs outlined above are followed, even the presence of corrosive coolant solutions should not cause corrosion problems. This was demonstrated in a service test of 12 vehicles at various locations throughout the United States for periods up to 4½ years. No control was exercised over the coolant, but 319-F alloy cylinder heads and metering gaskets were used. Even though high-chloride waters were employed in two instances, over 4 years of service produced no appreciable corrosion.

Increased Range for Large Aircraft

Research into methods of controlling the air drag boundary layer of aircraft has been pursued for some years. Reduction of the drag may lead to considerable increases in the endurance and payload capacity of large aircraft.

A TECHNIQUE known as Low Drag Boundary Layer Control (LDBLC) can be used to reduce the friction drag of an aircraft in flight. This technique, which has been developed by the Northrop Corporation in the USA, is not to be confused with other boundary layer control methods that are used to provide high lift performance on landing and take-off. After more than ten years of research and development, the Northrop LDBLC system is now believed to be applicable to any large, long-range aircraft to gain a substantial increase in endurance, range or payload.

The boundary layer itself is a very thin stratum of air that surrounds an aircraft in flight, lying directly on the aircraft skin. It is formed by air that is slowed down by the passage of the aircraft surface, and flows slower than the free stream velocity of the air around it. Boundry layer flow is smooth, or laminar, at its initiation, where it generates little friction. However, as the flow progresses backward along the surface it becomes turbulent. This turbulence causes large increases in air friction, resulting in drag on the aircraft.

By drawing part of the turbulent boundary layer air through slots in the aircraft skin with a suction compressor (see illustration) and exhausting it in the direction of thrust through the aft fuselage or the nacelle tailpipes, a continuing smooth flow of air can be obtained. Friction drag is then reduced to such an extent that either the range of the endurance can be increased by as much as 50 per cent. This increase could even approach 100 per cent if the technique were applied to most of the aircraft. For a given range and payload, or endurance and payload, therefore, an aircraft could be made considerably smaller.

ANY LARGE AIRCRAFT

According to Northrop engineers, LDBLC can be applied to any type of large aircraft, and existing automatic equipment can be easily adapted to perform the necessary slot cutting, drilling and milling operations. It is also said that other necessary structural modifications could be made with existing production techniques.

More than 300 laminar flow flights have been conducted with an American F94 jet fighter equipped with a slotted suction glove on one wing. Full laminar flow has been obtained in wind tunnel tests on a wide range of aircraft shapes, at speeds ranging from very low subsonic to high multisonic Mach numbers. Work is continuing at Northrop on supersonic laminar flow and on the application of LDBLC to fuselage and nacelle shapes, in addition to further work on wing and tail LDBLC.

Northrop's Norair division is now constructing two aircraft to demonstrate the new technique in full. The flight tests are scheduled to begin in about two years from now, when the aircraft will be flown on a regular day-to-day operational basis. The main object of this exercise will be to provide detailed manufacturing and flight operating data which will enable the technique to be made available to all types of large aircraft.

With low drag boundary layer control, flight efficiency could be increased and fuel consumption decreased to the point where aircraft could remain in station for considerable periods of time. This particular facet of LCBLC has extremely important applications in the field of military strategy—in fact the bulk of the development work has been carried out with this in mind.

MILITARY STRATEGY

Among the military activieis in which the endurance properties of LDBLC aircraft could play a vital role are:

Air to Surface Missile Carrier.—LDBLC aircraft could cruise outside the territorial limits and interceptor range of a potential aggressor, ready to launch a missile counter attack at a moments notice. Such aircraft could possibly remain in active flight for periods of up to four days.

Airborne Early Warning System.—With their long endurance and economy of operation, LDBLC aircraft containing radar and other detection equipment could operate with greater effect and efficiency than present day early warning techniques.

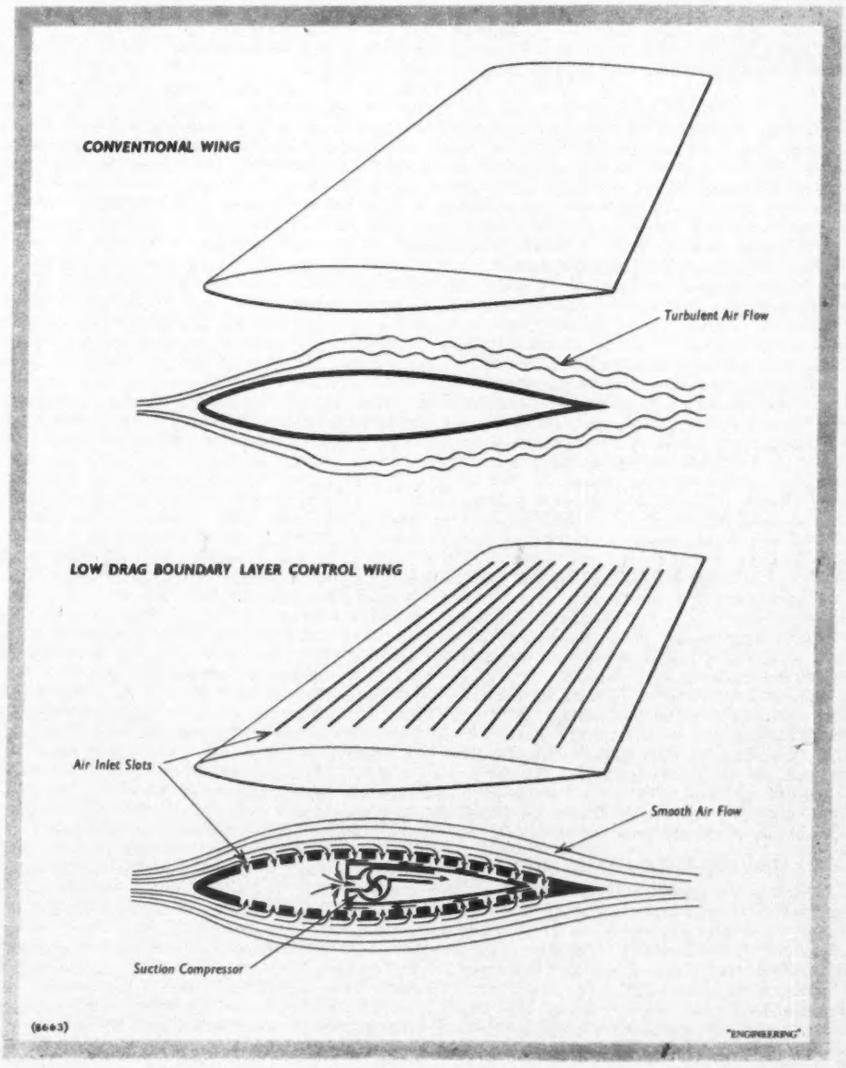
Intercontinental Communications Link.—High altitude nuclear explosions, or even natural phenomena such as sunsports, can black out existing types of long-range radio communication systems. A small number of LDBLC aircraft equipped with high-power communications transmitters and receivers could be kept in flight, spaced at suitable intervals, to act as relay stations. By such a technique, microwave communications links could be established over thousands of miles without fear of interruption.

Troops and Supplies.—The range advantages of LDBLC aircraft could enable non-stop airlifts of troops and supplies to be made over greater distnces, at lower cost and at higher speed than is possible at present.

Quite apart from its important military applications, low drag boundary layer control has an obvious, and very appreciable advantage in the field of commercial flight. Air freight could be extended far byond its present scope and costs of both passenger and freight flights could be reduced.

It is thought that incorporation of low drag boundary layer control would add approximately 10 per cent to the total cost of an aeroplane. Direct maintenance man-hours per flight would also increase, by about 15 per cent. Against this, however, there would be large economies in direct operating costs because of the reduced drag on the aircraft (which may be down by a factor of five) which will result in increased payloads and reduced fuel consumption.

A conventional aircraft wing creates turbulence and friction as it passes through the air. If the turbulent air is sucked in through slots in the wing, the boundary layer flows smoothly, thus reducing friction drag and increasing the payload capacity or range of the aircraft.



Parametric Amplifier will Improve Radar Performance

Now in an advanced state of development at Marconi's Wireless Telegraph Company Limited. is a parametric amplifier which promises to give a range improvement up to 25 per cent, which is equivalent to more than doubling the power on 50 cm radars.

This equipment is designed for eventual incorporation in new Marconi 50 cm equipments and will probably also be available as a modification kit for existing installations. In either case it provides notable advantages deriving from a fully coherent pump-frequency which is crystal controlled—the only one of its type in the world.

For some years, with the thermionic valve reaching its limit of economic development as an r.f. amplifier at 50 cm, the Marconi company has turned its attention to the development of alternative methods.

At 10 cm and 23 cm wavelengths, considerable development has been done with travelling wave tube amplifiers, while at 50 cm the company has concentrated its effort in the design of an electron beam parametric amplifier. Apart from improvements in signal-to-noise ratio, both travelling wave tubes and parametric amplifiers are inherently far more robust, and power spikes from the transmitter are unlikely to cause performance to deteriorate as is the case with crystals or thermionic triodes.

In the parametric amplifier, amplification is achieved by the application of a radio frequency signal (usually of higher frequency than the one to be amplified) as a source of drive to the tube in such a way that the input signal, in its passage, draws power from the drive. The tube is inherently a low noise device with broad band characteristics.

For practical reasons a drive (or pump frequency) of approximately twice the signal frequency is usually employed and under these conditions—that is, with the pump frequency non-coherent with the signal—two sets of signals, each with its own noise, are produced. These are equally spaced above and below a datum line located at half the pump frequency. Under these circumstances the tube provides gain and signal-to-noise figures which are already better than those obtained with a thermionic triode.

Marconi's have made a significant advance in technique in their amplifier by making the pump frequency exactly twice that of the signal frequency. The two are locked under crystal control, and under these conditions the two sets of signals referred to above now merge and are additive in terms of voltage. The two bands of noise, however, are still non-coherent and these only add in terms of power. The net result is a signal of considerably increased amplitude but a much smaller increase in noise level.

To sum up, the inherent capabilities of the parametric amplifier can only be exploited to the maximum in a fully coherent system. In this connection it is worth noting that the Marconi 50 cm radars employ an efficient and fully coherent moving target indicator (MTI) system, which is locked by the same crystal control as the rest of the system.

Doubts About Preserving Food by Irradiation

Refrigeration and canning have long been the best and most commonly used techniques for preserving foodstuffs. In recent years, however, other techniques have emerged offering some advantages. The most important of these, but one about which there are many doubts, is preservation by irradiation.

At the Low Temperature Research Station, Cambridge, work has been in progress on radiation preservation for some years, the main emphasis being on animal products. Work has been largely centred on radiation-pasteurised meats stored at temperatures near freezing point.

Some experiments which necessitated the use of sterile samples have confirmed earlier experience that meats given sterilising doses of radiation are of unacceptable quality. It has been reported previously that meats which have been sterilised with radiation tend to improve in flavour during storage, particularly at elevated temperatures. However, experience at the Low Temperature Research Station has been to the contrary. They find that the odours and flavours characteristic of irradiation do tend to disappear, but the flavour of the stored meats becomes worse than that of freshly irradiated samples, which is itself already very poor. Deterioration progresses during storage, and is more pronounced at higher temperatures. There has recently been considerable discussion of the extent to which such deterioration during storage is due to enzyme action, and claims have been made that autolytic changes can be prevented by treatment of the live animals with adrenaline. Experiments on the effects of irradiation on enzyme activity in beef and pork, and the changes in quality during storage have therefore been started.

Further experiments on the pasteurisation of whole chickens have indicated that quality changes with doses up to about 800,000 rads of γ-radiation from Cobalt-60, are insignificant; there is a slight pinkness in the flesh; a very slight, but not objectionable, odour in the raw meat; and after roasting in the normal way, the irradiated meat is seldom distinguishable in flavour and texture from ordinary roasted chickens. A dose of 800,000 rads delays microbial spoilage of chicken for 55 to 60 days, in storage at 1° C where unirradiated meat usually spoils in about 10 to 12 days. With smaller doses of radiation, a proportionately smaller increase in storage life is obtained. At higher temperatures, the storage life is reduced: 21 days at 5° C and 17 days at 10° C were observed with 800,000 rads. The storage temperature should be lower than 5° C to prevent hazard from anaerobic bacteria like *Clostridium botulinum*. The combination of a chlortetraycline (Aureomycin) dip treatment with irradiation (125,000 to 500,000 rads) prevents microbial spoilage for periods greater than either treatment alone: the increases are roughly additive. Antibiotic treatment has given no increase in the storage life of chickens irradiated with 800,000 rads.

QUALITY SPOILT

Although irradiation is very effective in retarding microbial spoilage, examination of the quality of the chicken meat during storage presents a less encouraging prospect. For rather more than two weeks, the irradiated chicken remains comparable in quality to fresh chicken; but after this time a rather rapid decline in quality occurs, and while the chicken meat does not become actually distasteful, it loses the attractive flavour characteristic of fresh chicken. After three weeks, the irradiated chicken is significantly inferior to fresh, or even frozen, chicken, and this decline occurs with low or high doses, with or without antibiotic treatment. These changes have been observed with a panel of 10 experienced tasters; and confirmed by a panel of about 130 voluntary domestic consumers who ate the chicken as part of a normal meal, and unlike the taste panel, did not have fresh chicken for comparisons during tasting. Only about 5 per cent of the domestic consumers noticed the slight pinkness of the raw meat, and no adverse comments were made on the odour. The conclusion is that chicken pasteurised with radiation remains of high quality during storage at 1° C for about one and a half times as long as the total storage life of an untreated chicken; after this period the quality of the irradiated chickens declines.

Various research workers have reported that such deterioration during storage is due to oxidative rancidity of the fat. This has not been the experience at the LTRS with chickens; storage of irradiated carcases (700,000 rads) for up to six weeks at 1° C, in the presence or absence of oxygen, showed that those stored in the absence of oxygen deteriorated more rapidly.

IMPORTANCE OF OXYGEN

This result illustrates the complexity of the influence of oxygen upon the quality of irradiated meats. To achieve the maximum microbiological effects during irradiation, the presence of oxygen is desirable; but it has commonly been reported that this leads to more adverse quality changes in foodstuffs. In the experience of the LTRS, this is not always the case. On the other hand, during storage oxygen can cause oxidative rancidity, and this has been observed with some foods other than chicken. Experiments with cuts of beef treated with γ-radiation, in the dose range 25,000-100,000 rads, to prolong the storage life at − 1° C have shown that doses which appreciably delay formation of slime by bacteria, considerably enhance the risk that the fat will become racid during storage. Similarly, the flavour deterioration during storage of pork sausages treated with pasteurising (1,000,000 rads) or sterlising doses (5,000,000 rads) is of a nature suggesting that the fat in sausages is becoming rancid. With smoked bacon also, irradiation with doses in the range 50,000-500,000 rads showed that samples which had been irradiated and stored without oxygen were preferred.

Obviously, quality change due to rancidity is understandable, and can be prevented. Why it should happen with some meats, but not with chicken, is less easy to understand. The effects of oxygen on quality changes immediately after irradiation are also perplexing. With chicken meat, samples irradiated in the presence of oxygen have usually been preferred for flavour and odour, though the change to a greyish colour is less attractive than the pink produced in the absence of oxygen.

Investigations on the influence of freezing meats during irradiation have been made, and have given some quite striking results. With pork irradiated at room temperature and at − 75° C, samples irradiated with 5,000,000 rads in the frozen state were preferred to those which had received only 500,000 rads at room temperature when the assessment was based on the odour of the uncooked meat; assessment after cooking showed a lesser gain as a result of freezing, samples of comparable quality being obtained when the dose given to the frozen pork was about 2½ times that given at room temperature. With beef, the corresponding gain due to irradiating in the frozen state was a factor of four for odour and about one and a half after cooking. Investigations of pork and beef, of both quality and chemical changes (alteration of pH, destruction of glutathione, formation of methyl mercaptan), indicate that most of the protection due to freezing occurs in the temperature range 0° C to − 20° C. Detailed study in the range just below freezing point shows a sharp transistion between − 3° C and − 6° C, the exact temperature of this transition depending on whether the meat is brought to the temperature from above or below. Inactivation of bacteria follows a similar pattern. This suggests that the effect is connected with the freezing of water in the tissues.

Welding Research Finds New Ways

Modern welding operations frequently involve the use of new materials and working to standards that were inconceivable only a few years ago. As a result of this, the British Welding Research Association has been increasingly called upon in recent years to meet specific problems in design, selection of welding conditions and choice of materials.

This is particularly evident from the latest annual report of the Association which, in referring to the need to increase its income solely on the basis of its present commitments, points out that a programme more than double the size of its present one is now in hand.

In outlining its work the Association shows how some of its apparently esoteric activities have a really practical bearing on industrial problems and economics. The fundamental study of the welding arc—long regarded only as a source of heat—is thus seen in relation to filler wire diameters and compositions, the development and improvement of welding equipment, methods of gas shielding and the establishment of optimum welding conditions for the whole range of structural metals.

The replacement of mechanical joints by welded connections in high pressure small bore pipe systems could provide a far reaching economy in the construction of chemical engineering plant, and investigations recently carried out have shown this to be a practical possibility. Similar economy-based and rationalised design studies in the fields of pressure vessel construction have indicated the need for a revision of established standards.

In regard to the widely shared problems of metal fatigue and brittle fracture, the results of experimental work on the controlled use of local heating and mechanical conditioning as a means of increasing strength have been verified and it has been shown that service life can be extended far beyond the levels at which failure would normally be expected to occur.

INCREASED FATIGUE STRENGTH

In the design of structures subjected to repeated loading it is often necessary to use very low design stresses because of the poor inherent fatigue strength of some of the welded details. A particular example is the discontinuous longitudinal weld which may be used for the joining of flanges at right angles and for the attachment of girder stiffeners, gussets and similar components. It is well known that, under fatigue loading conditions, failure will occur at the ends of such welds.

Work in Czechoslovakia has shown that, by artificially inducing residual compressive stresses at these expected points of failure, large increases in fatigue strength can be obtained. These findings have subsequently been confirmed by the BWRA; the residual stresses being induced both by "spot heating" with an oxyacetylene torch and by "local compression" of the specimen to produce plastic flow mechanically.

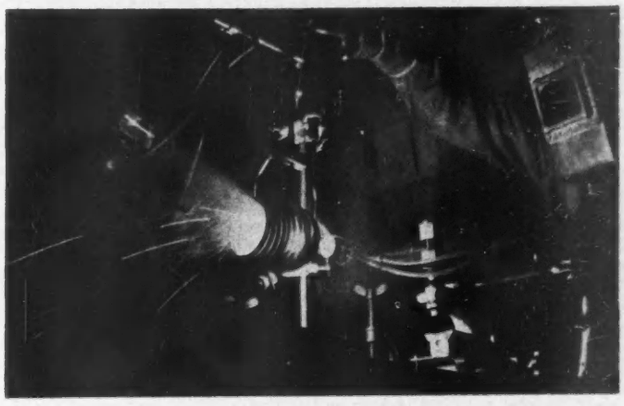
During the past year, a thorough investigation of the effect of residual stresses on the fatigue strength of a mild steel specimen containing a non-load-carrying welded joint has been completed. It has shown that the strength, at 2 million cycles, of a welded detail of this kind could could be increased by approximately 150 per cent by means of the local mechanical treatment. In addition, tests of similar specimens in the stress relieved condition carried out under different ratios of maximum to minimum stress (different mean load conditions) have indicated the reason for the increased strength by the new technique.

As the mean stress is decreased, the range of stress sustained at the fatigue limit is not markedly influenced until the mean stress becomes compressive. The tolerance stress range then increases significantly as the magnitude of compressive mean stress is increased. The tests of specimens given the local mechanical treatment imply, therefore, that the induced compressive stress has the same effect as a mean stress applied by external loading. At the present time the investigation is concerned with load-carrying fillet welded joints in mild steel, and with both load-carrying and non-load-carrying fillet welded joints in aluminium alloy (NP5/6).

Results of these tests have also been encouraging in that increases of fatigue strength (at 2 million cycles) of the order of 100 per cent have been consistently produced in both materials and joint forms. Collectively, these results provide adequate proof of the potential value of spot heating and local compression.

Further work at the BWRA will be directed toward understanding some of the basic aspects of this new technique, with a view to ironing out some of the problems of its practical application in industry.

The illustration above shows work being carried out at BWRA on the fundamental phenomena associated with the welding arc. Experiments are being conducted in which a filler wire is fed into an arc maintained between non-consumable electrodes. The influence of electrical variables on the melting filler wire can thus be determined, and ballistic experiments can be made to give some indication of the arc forces. The coil shown in the illustration is used to provide a rotating magnetic field to prevent the arc burning through the anode.



Fundamental studies of welding arc phenomena are being carried out by the British Welding Research Association.

Technique for Superconductivity Studies

A new technique for the study of superconductivity (a property through which certain materials lose all their electrical resistance at nearly 0° K) has been developed at the research laboratory of General Electric, USA.

Direct visual observation of transformations between the normal and superconducting states can be made by this new method. Magnetic and optical effects are employed to make visible the changes taking place in the "intermediate state," a condition in which some portions of the sample are superconductive and others are normal. The intermediate state is of considerable practical, as well as scientific, interest. Its structure and the manner in which it changes when subjected to a magnetic field are strongly affected by impurities and by any metallurgical treatment of the specimen.

Already the new technique has produced some useful information; in particular on the motions of normal and superconducting "domains," which could not be observed before. It is also a quick and accurate method of measuring certain basic magnetic properties of superconductors.

The basis of the new study technique is the fact that, although a sufficiently strong magnetic field can make a superconducting material revert to normal, the material is a perfect insulator so long as it remains superconductive.

In order to observe the specimen it is usually prepared in the form of a flat disc or plate, although thin vacuum deposited films have also been studied in this manner. A plate of a special cerium phosphate glass about one-hundredth of an inch thick is placed on the sample. When magnetised, this glass has the property of rotating the plane of polarised light. Monochromatic polarised light is beamed on the glass, and the reflected light is viewed through a polarising filter which can be rotated to any desired angle.

The material under study is normally cooled in liquid helium to a temperature slightly above absolute zero. At this temperature it is superconductive, but it can be changed back and forth between superconductive and normal by a varying magnetic field. At certain magnetic field strengths, the specimen is in the intermediate state, with some portions normal and others superconductive.

Since the superconductive areas shield portions of the glass plate directly above them from the magnetic field, these parts are not magnetised; similarly, glass areas directly above normal segments in the sample are not shielded and become magnetised. These areas rotate the plane of the polarised light they reflect, whereas the shielded parts reflect in the same plane. By adjusting the polarising filter through which the reflected light is observed, the magnetised portions of the glass can be made to appear dark and the unmagnetised portions light, or vice versa. Since the pattern of light and dark corresponds exactly to the pattern of superconducting and normal metal in the sample, changes in the state of the sample can be observed, and even photographed, directly.

Shoe Drill for Hygiene

THE sole of a shoe comes into contact with a tremendous number of substances during its life. Unfortunately many of them are counted foul, and efforts are always being made from earliest childhood to prevent these foul substances being brought into the clean house, and even more into the clean hospital. "Wipe your feet" is one of the first orders to the toddler.

In the country (and in the towns until comparatively recently) a standard item at the front door is the scraper. Then there is the coconut mat (with or without "welcome" on it) that graces the inside of the doorway. A great collector of dirt and quite a problem to clean is the door mat; shaking and beating are operations only to be performed by the physically fit and then preferably only in the seclusion of a yard. But modern times, modern manners and in a mechanical age what better than a mechanical door mat?

The Miracle mat comes from Holland, Michigan, where it is made by the Progressive Engineering Company. (Their export agents are the Midwest-Overseas Trading Corporation 647, West Virginia Street, Milwaukee 4, Wisconsin, USA.) It cleans the soles of the shoe as soon as the wearer steps upon it. The construction is an aluminium grille with brushes mounted between the bars. Placing the weight on the grille depresses it slightly, enough to make a pair of contacts and start a motor that reciprocates the brushes at about seven strokes per second.

One of the many standard sizes measures 31¼ in by 31½ in across the grille (40⅝ in square over the frame) and requires an opening in the floor 37½ in square. There are 63 slats at ⅝ in spacing and the whole grille floats on rubber cushions at three points. The 20 brushes are made of nylon or prostan mounted on rods 31 in long, which oscillate in nylon bearings. Adjustment is provided for wear.

Power to drive the brushes is provided by a splashproof ¼ h.p. motor, and dirt removed falls into a pit which can be provided with water flushing. In shops or public buildings, the mat can be used as part of the warm air curtain for the doorway, or stepping on the grille can be used to actuate a door opener. It is claimed that cleaning costs within the building are substantially reduced and so is wear and tear on carpeting.

No amount of brushing can remove all dust particles or micro-organisms. Where absolute cleanliness and sterility is required (as in some hospitals and in some modern industrial processes) a different form of collector is available—the Taccy mat. A product of Anti-Dust Services Limited, Dudley, Worcs., Taccy mats are not intended to remove street dust and dirt; their purpose is to collect the fine dust particles and organisms that are left after rough dirt has been removed. A typical application is between wards of a hospital to prevent dust being carried from one to another.

The standard mat has a base of plastic foam 1½ in thick so that the maximum area of the instep will be reached. Over the foam is a replaceable cover with a surface to which fine dust will adhere. Feet or trolley wheels passing over the surface are cleaned, and pathogenic bacteria rendered immobile and harmless. Coverings are also available to which a disinfectant has been added to give additional protection. Used coverings are removed and burnt. The 1½ in thick mats are 28 in wide by 18 in long and the thinner, ½ in, versions 30 wide by 18 in long. Similar coverings are made for brooms.

Mats, even good mats, only clean the sole of the shoe. For the uppers there is the Peugeot Easishine power driven polisher sold here by Rudson Wood and Company, Limited, Kilburn High Road, London, NW6. The machine is a nice size for the hand and the case is made of impact resistant plastic. A small motor, for standard mains supplies, drives the rotary brush at high speed, controlled by a switch conveniently placed for the thumb. Interchangeable brushes are supplied as well as polishing pads. A lambswool pad is included to enable the unit to be used for polishing furniture. There should be no excuse now for not having a Guards shine every day.

(Left) Shoes, muddy from the street, have their soles automatically cleaned by power driven brushes in the Miracle mat.

(Below left) Fine dust and pathogenic bacteria from shoes or trolley wheels are collected on the replaceable surface of the Taccy mat.

(Below right) The Easishine lives up to its name for polishing the uppers of the shoe.

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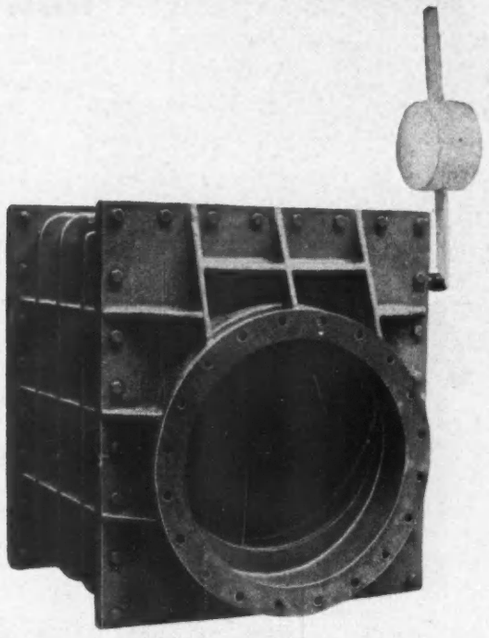

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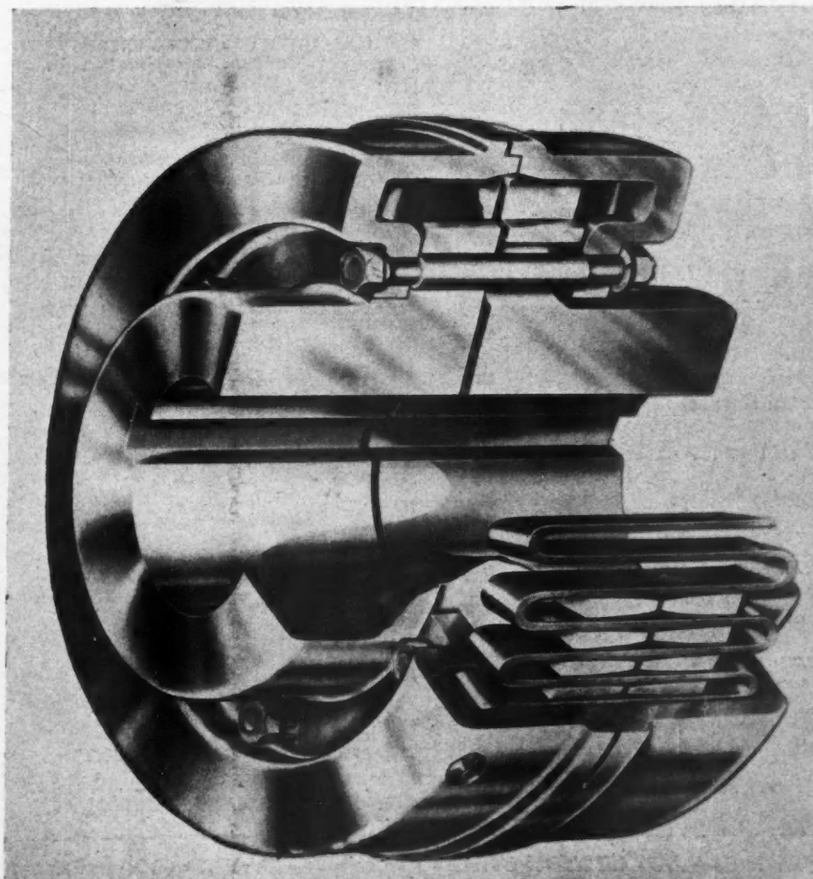

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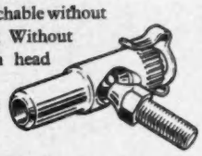

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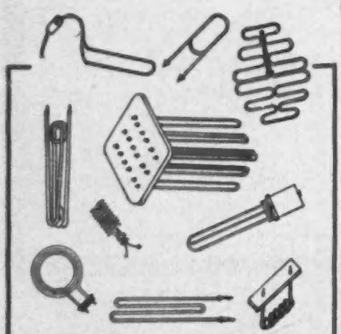

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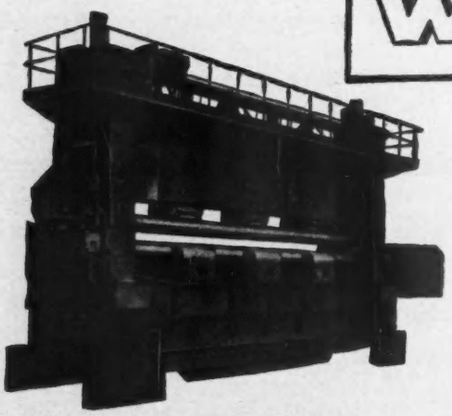

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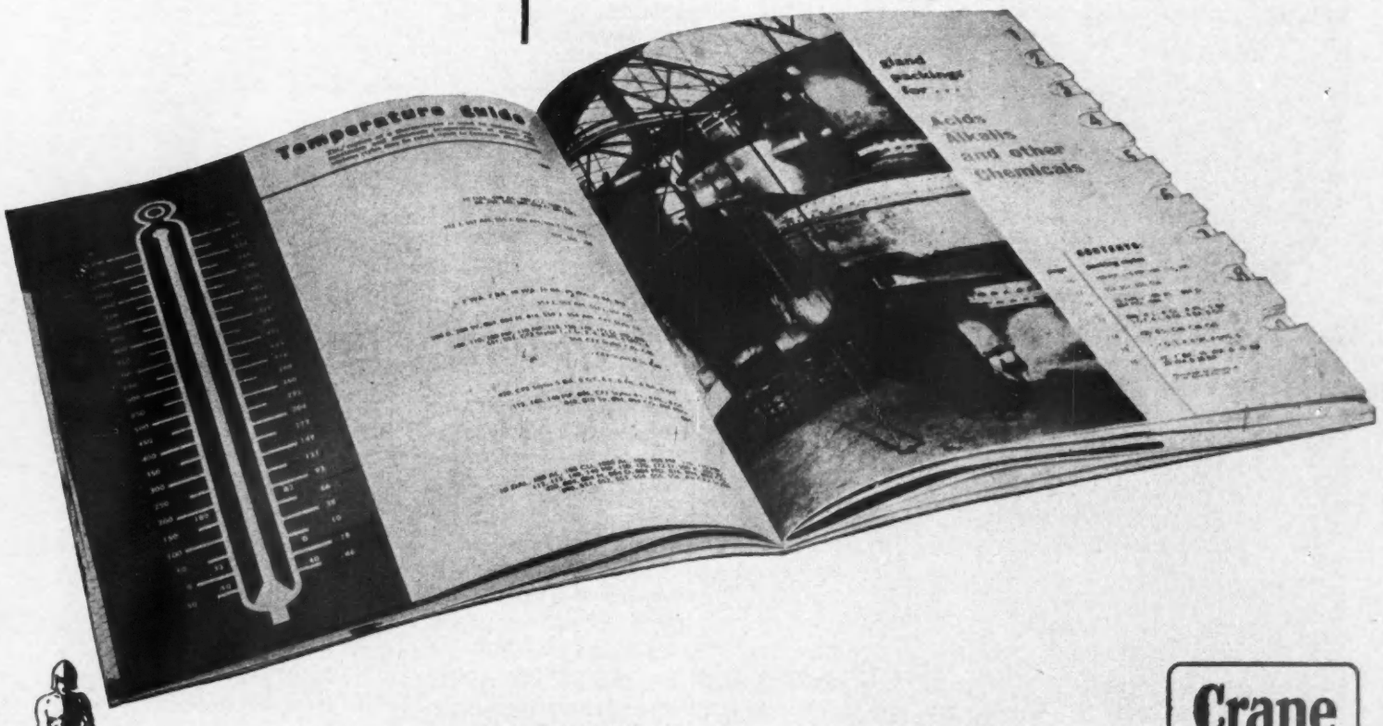

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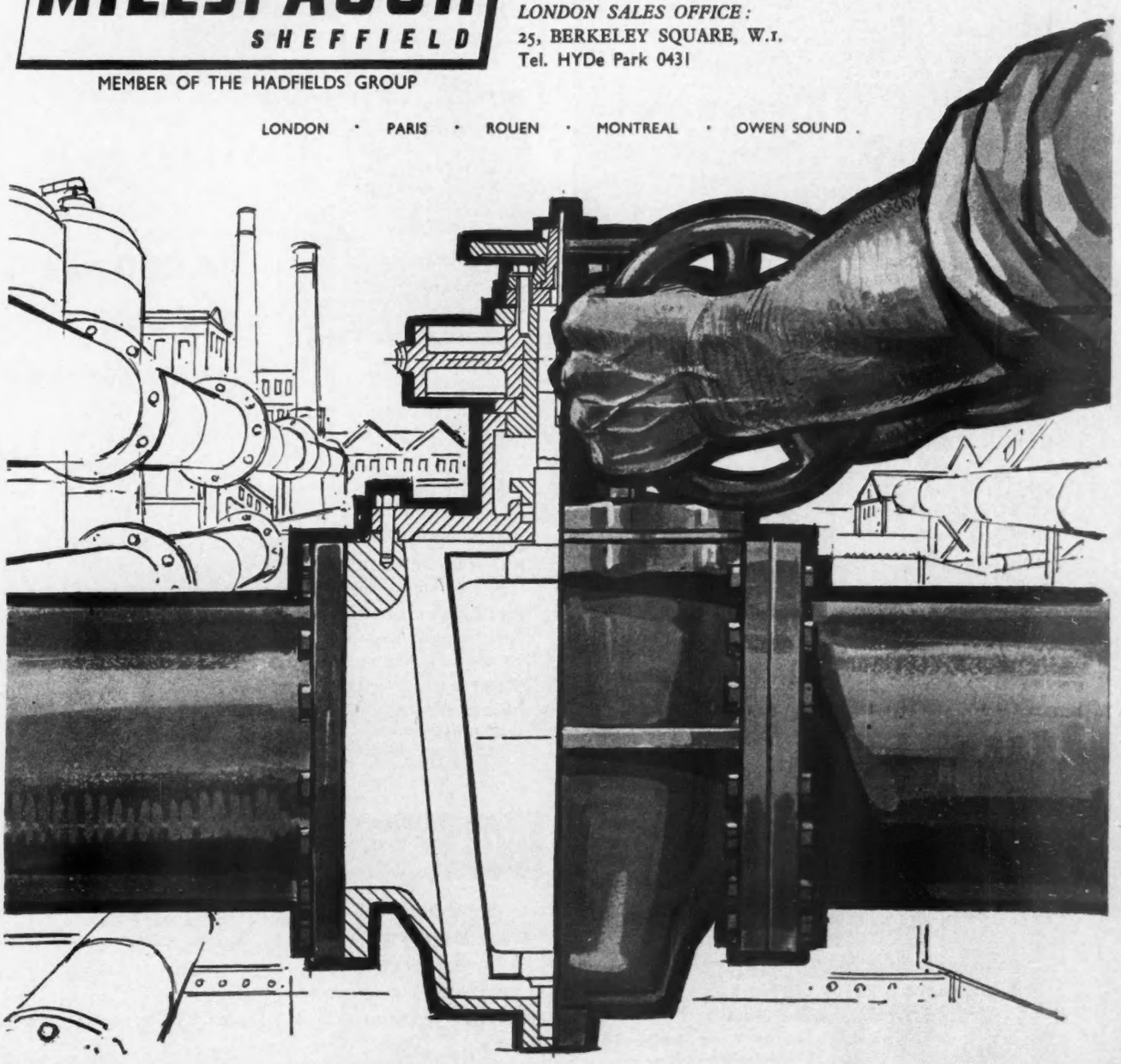

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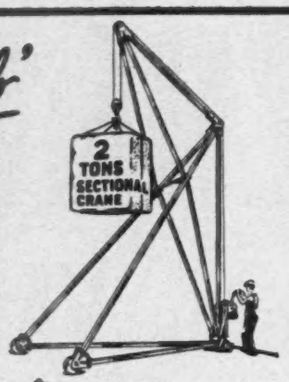

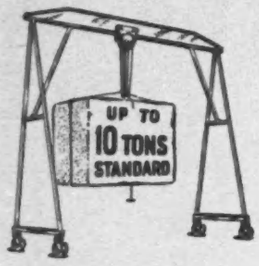

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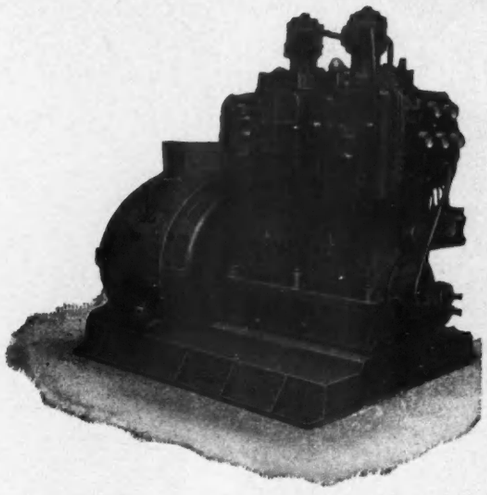

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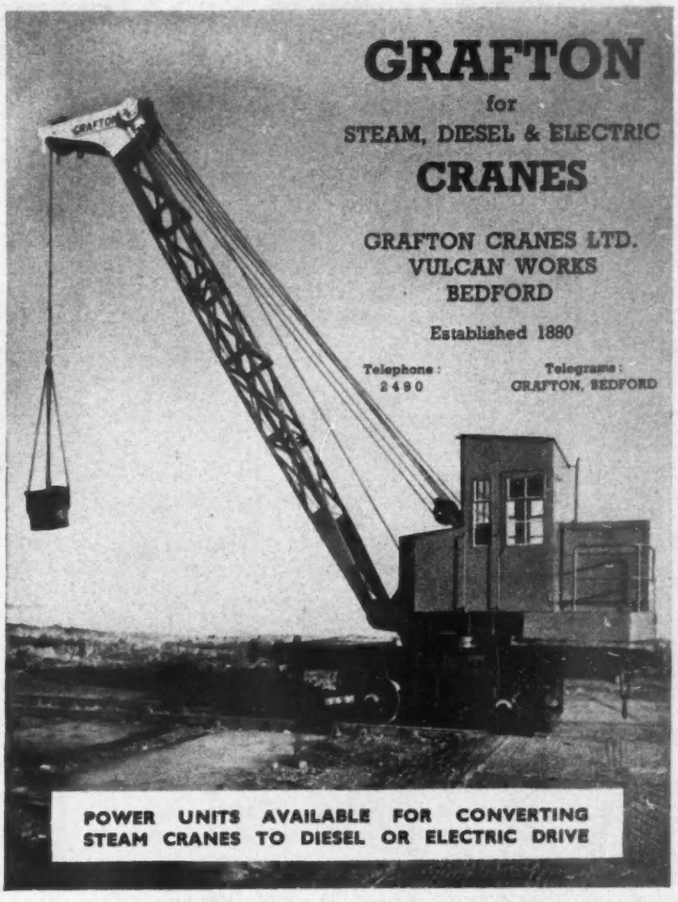

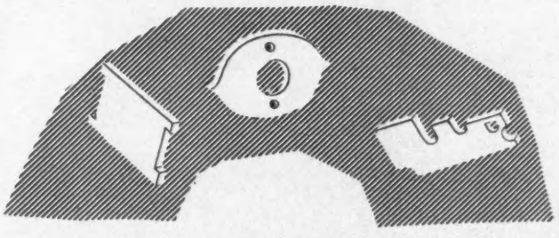

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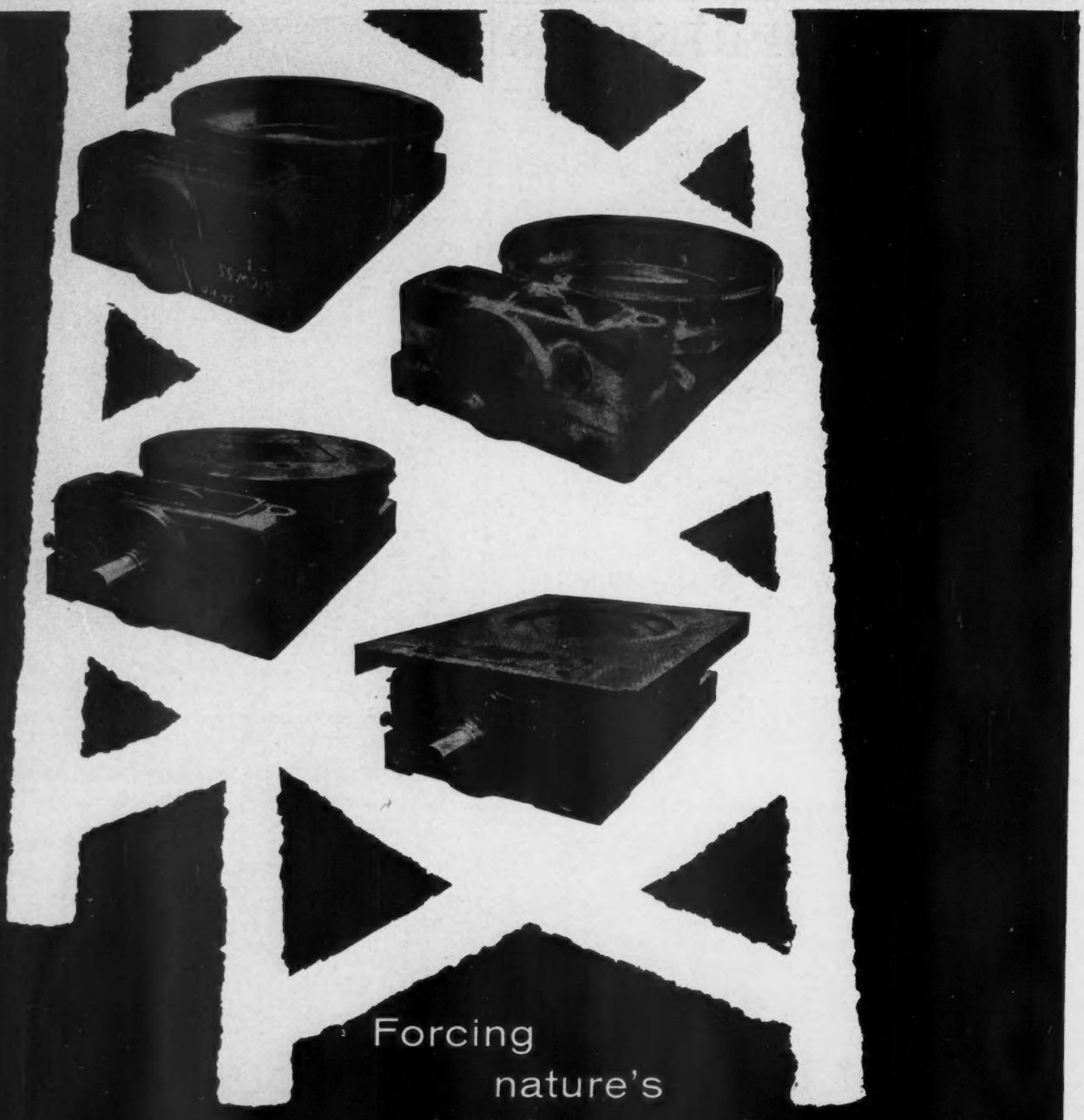

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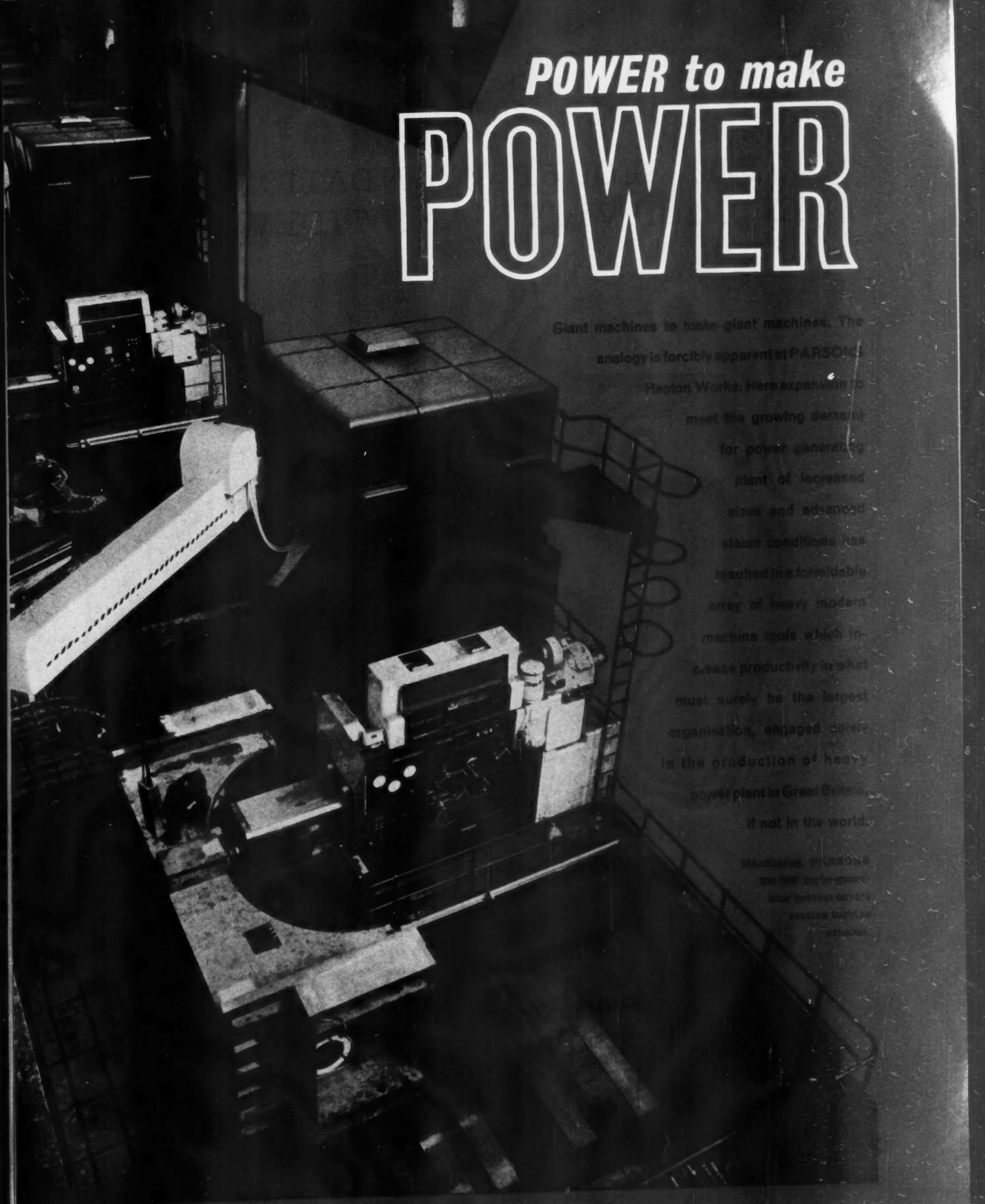

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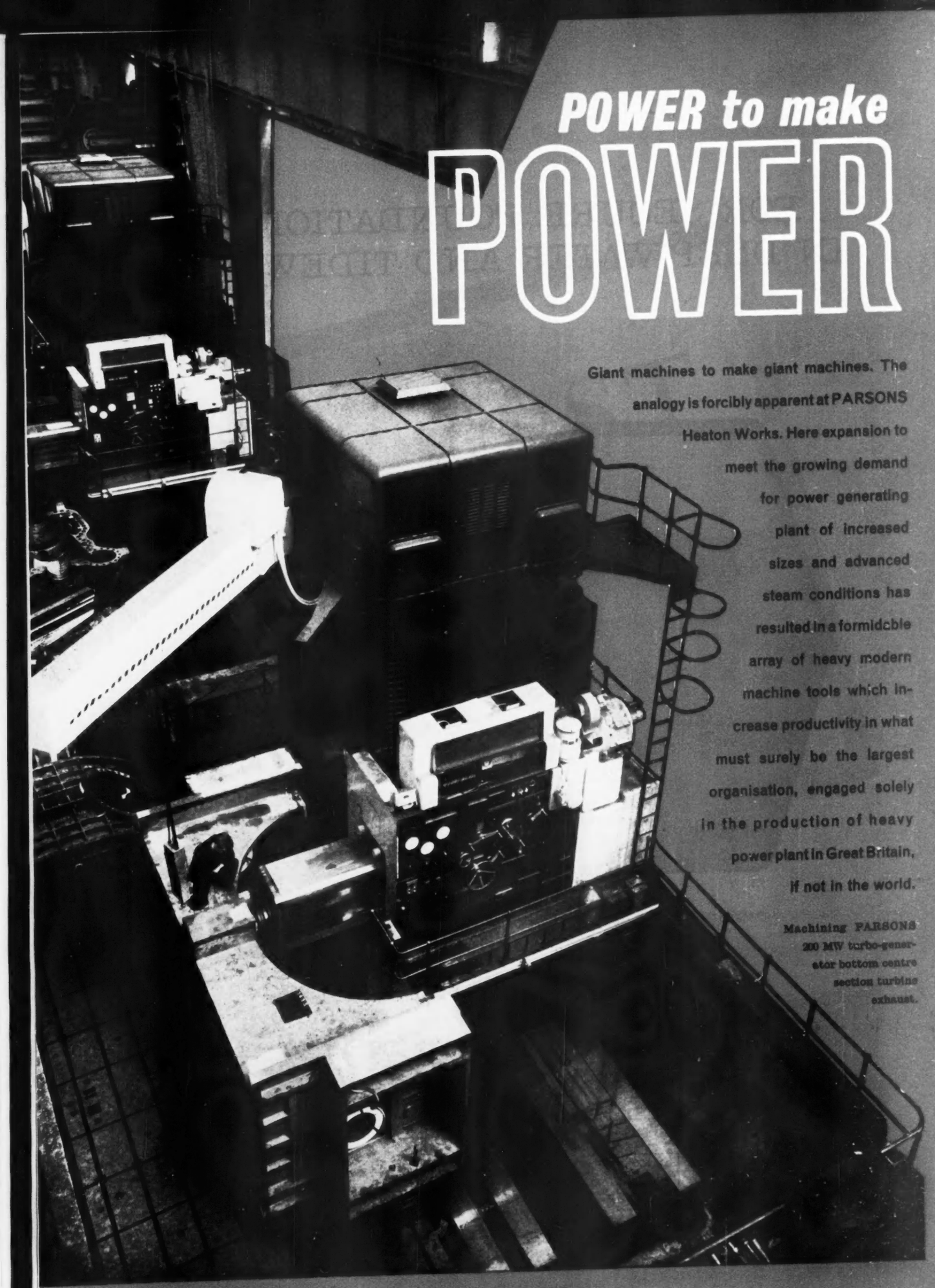

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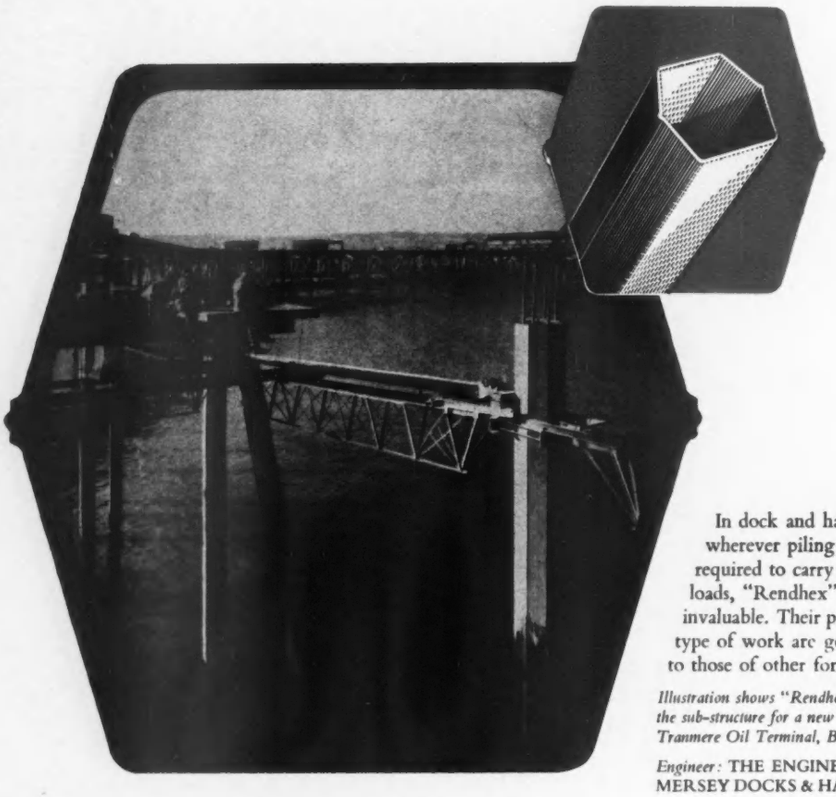

In dock and harbour installations, wherever piling construction is required to carry heavy vertical loads, "Rendhex" Columns are invaluable. Their properties for this type of work are generally superior to those of other forms of piling.

Illustration shows "Rendhex" Columns forming the sub-structure for a new oil tanker jetty at Tranmere Oil Terminal, Birkenhead.

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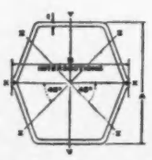

TABLE OF PROPERTIES

"Rendhex" Column No.	Size (Ins.) A	B	t	Weight of Rolled Section lbs. per Lin. ft.	Weight of complete Col. (incl. Weld) lbs. per Lin. ft.	Area of complete Col. (excl. weld) Sq. ins.	Moment of Inertia (Ins.⁴) About XX	About YY	About ZZ	Radii of Gyration (Ins.) About XX	About YY	About ZZ	Section Moduli (Ins.³) About XX	About YY	About ZZ
No. 3	13	12⅞	½	36·15	72.50	21·26	469·3	381·3	425·3	4·69	4·23	4·47	72.20	58·70	57·30
No. 4	16	16⅛	½	58·30	117·75	34·30	1214	1038	1126	5·95	5·50	5·73	151·75	125·82	116·15
No. 6	20	20	0·7	80·70	162·80	47·47	2657·7	2203·5	2430·6	7·49	6·81	7·16	265·80	218·60	207·20

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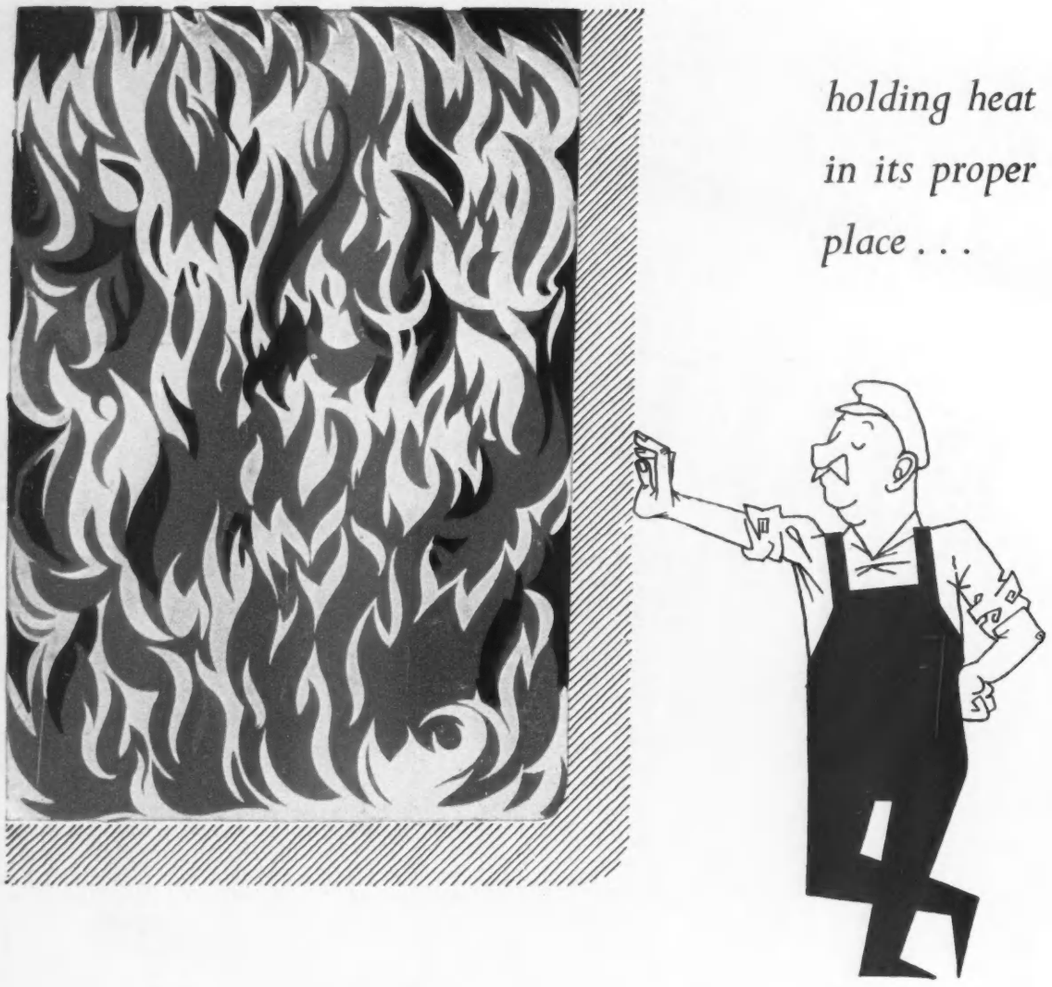

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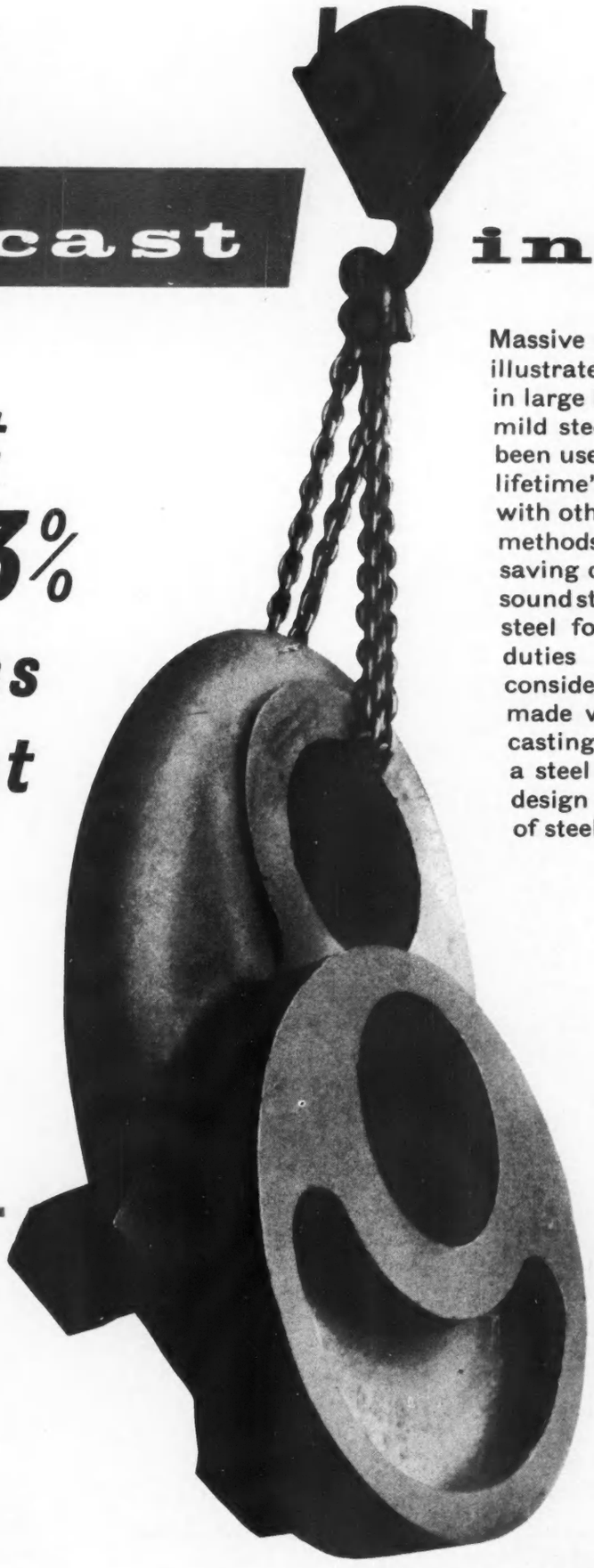

Massive Webs, such as the one illustrated, are cast in steel for use in large Marine Engines. Made in mild steel, similar castings have been used in crankshafts to give a lifetime's service at sea. Compared with other and earlier production methods, they show a direct cost saving of 13% and illustrate how sound steel castings from a modern steel foundry can meet arduous duties at less cost. Have you considered if this economy can be made with your components by casting in steel ?. Why not call in a steel foundry engineer at the design stage and take advantage of steel foundry know-how.

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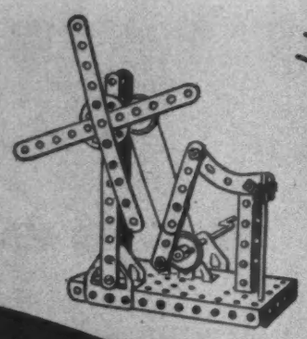
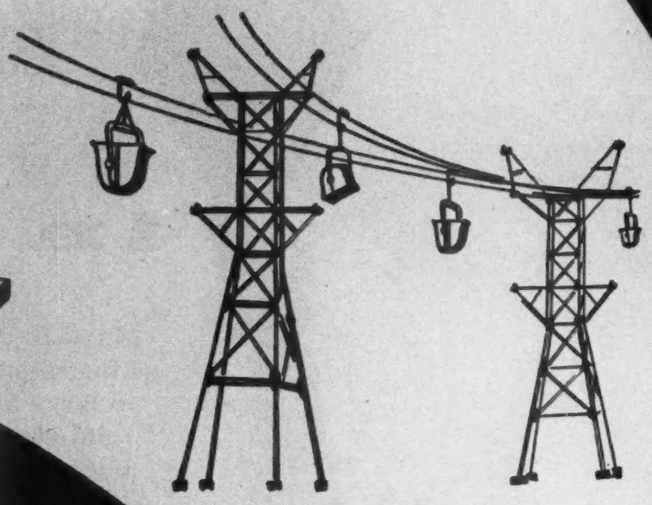
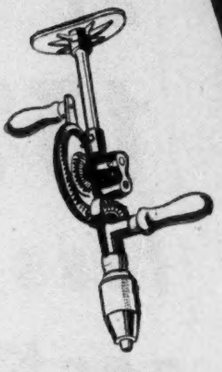
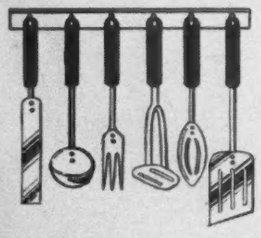
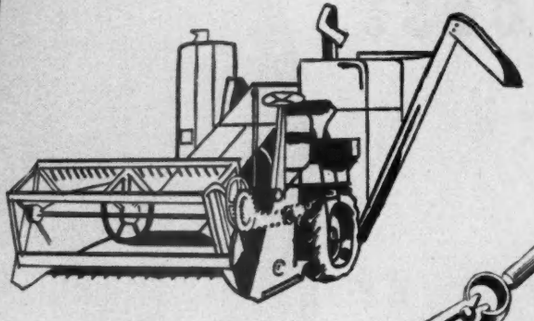

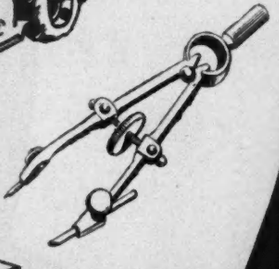
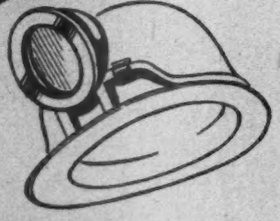
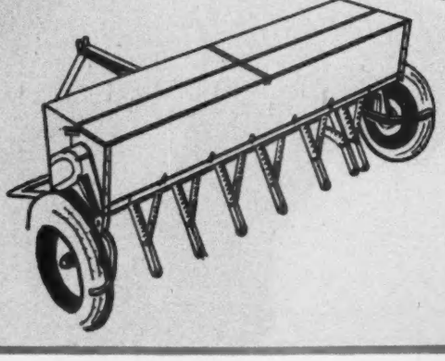

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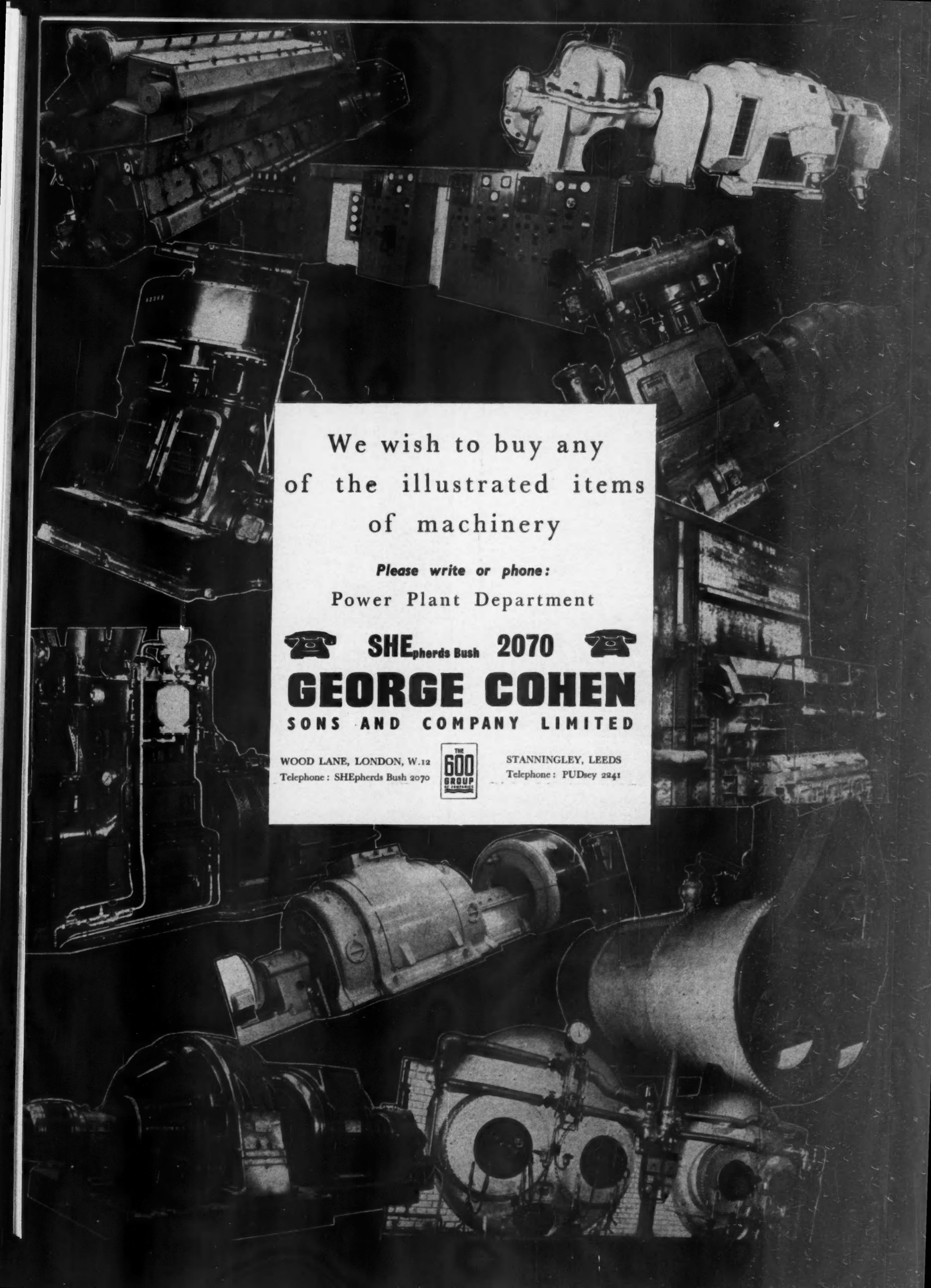

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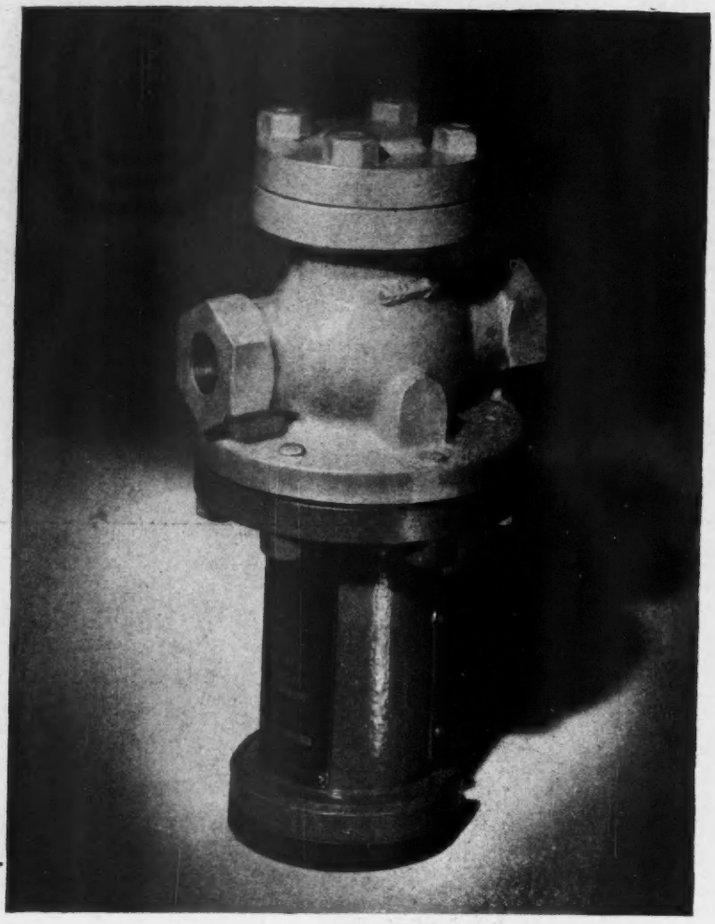

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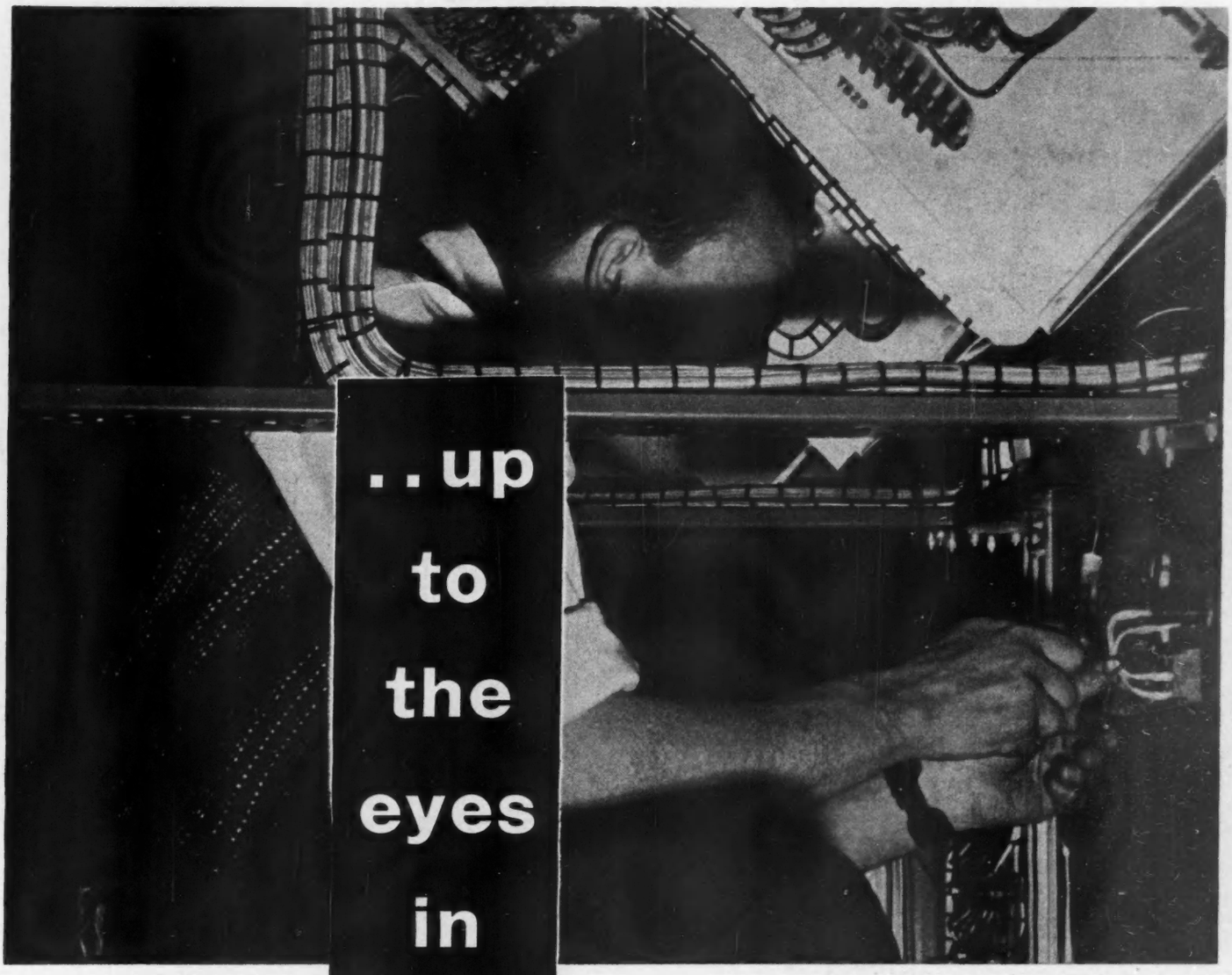

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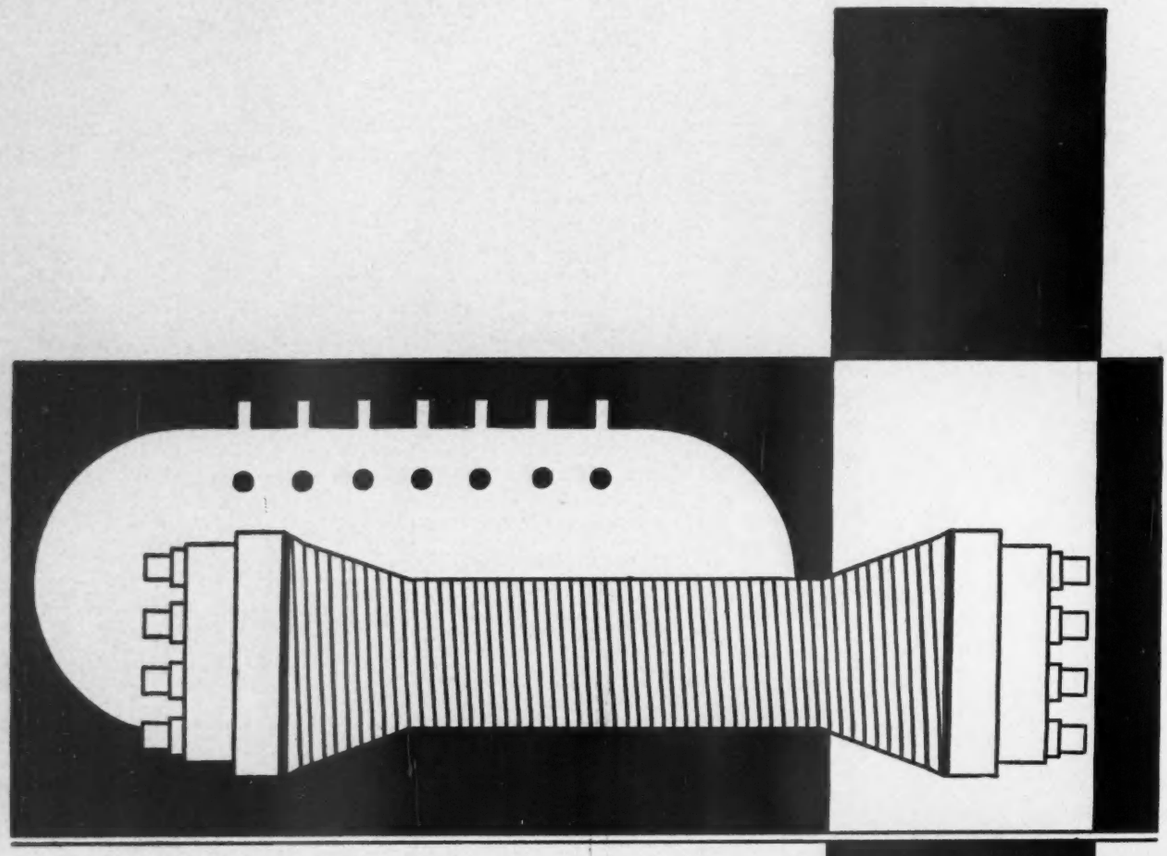

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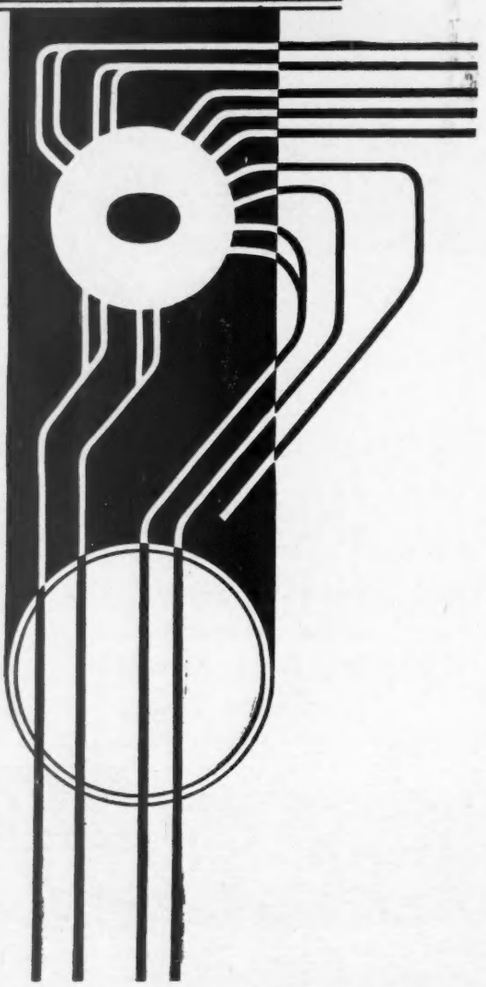

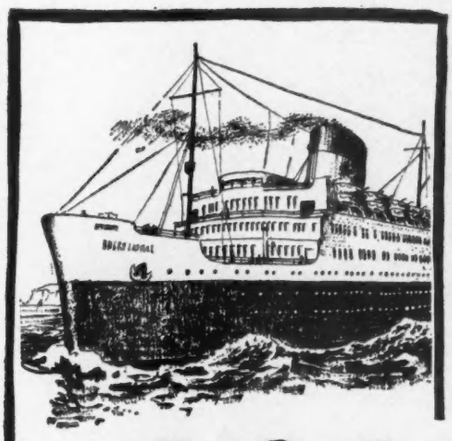

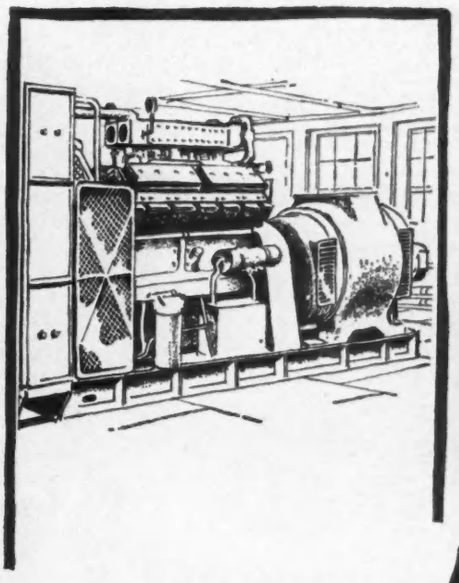

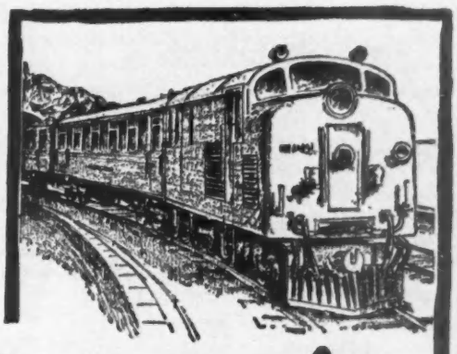

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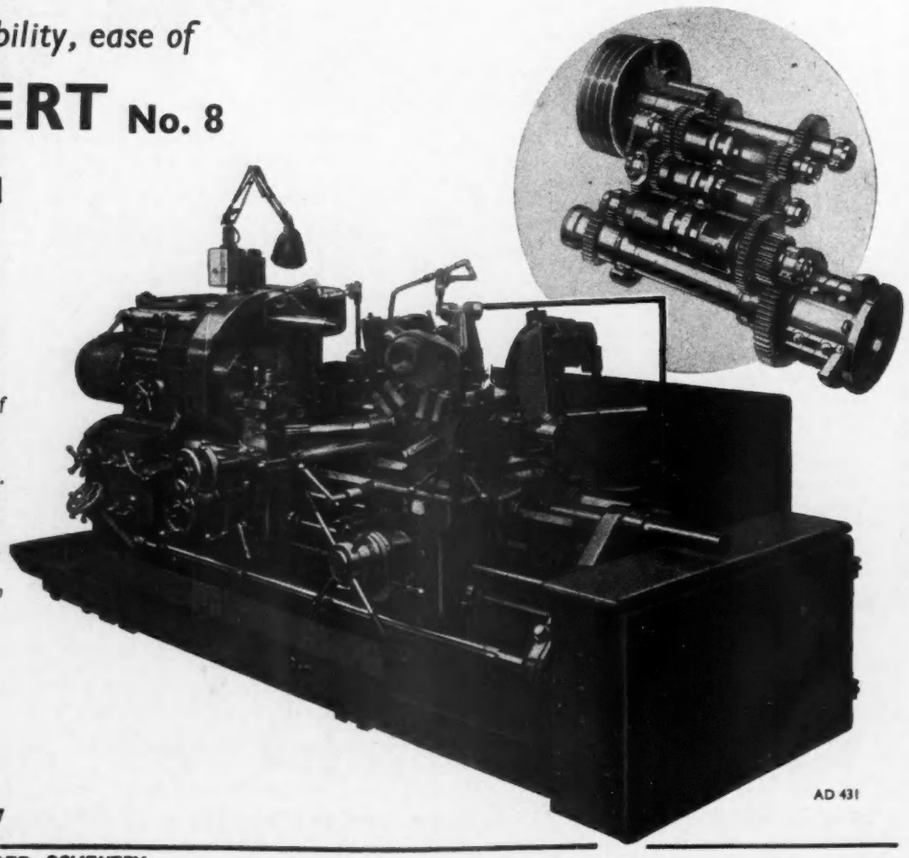

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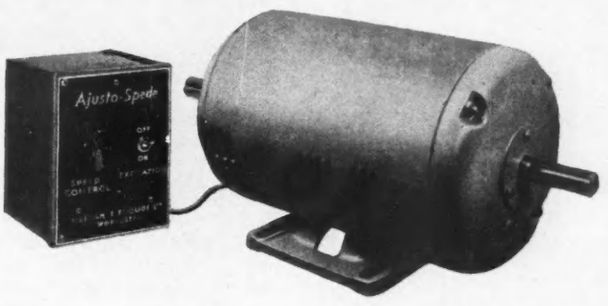

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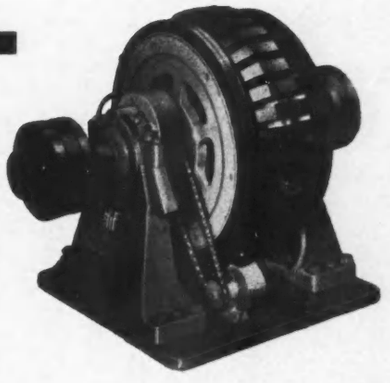

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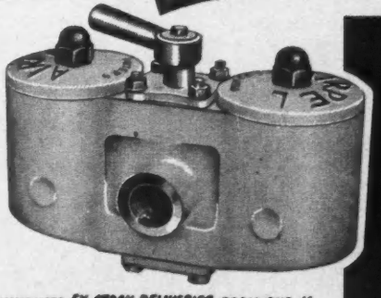

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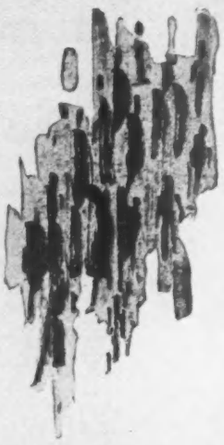
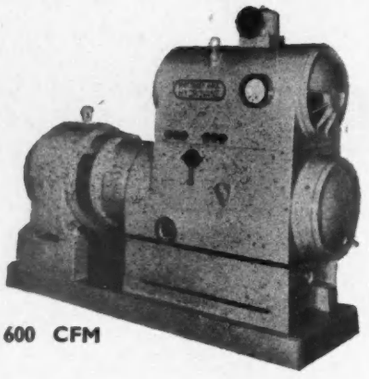
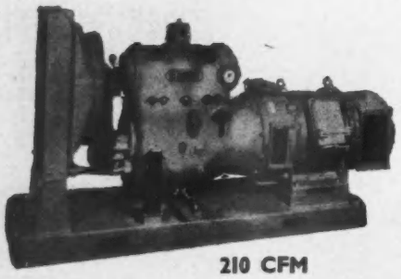




600 CFM



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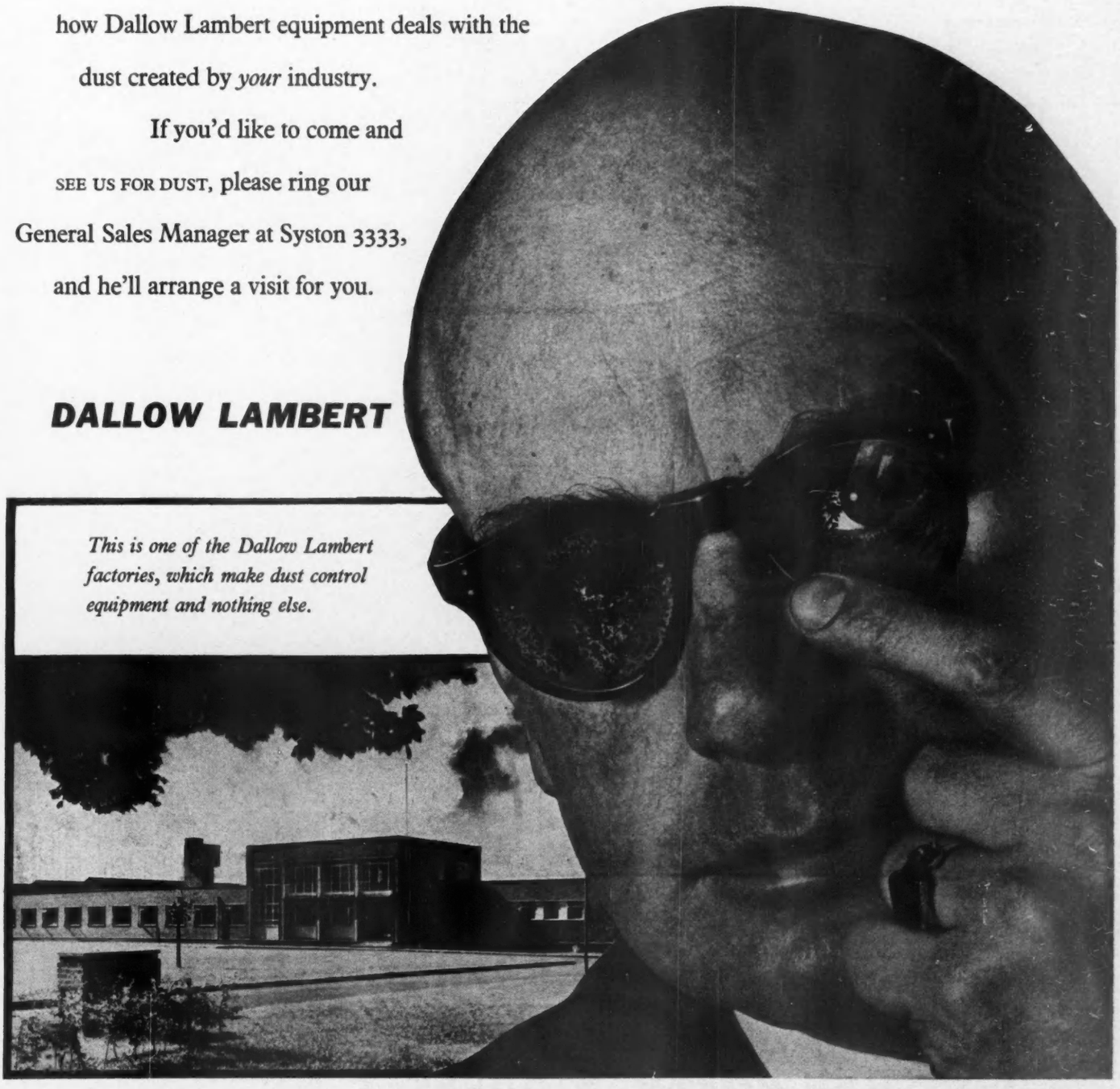

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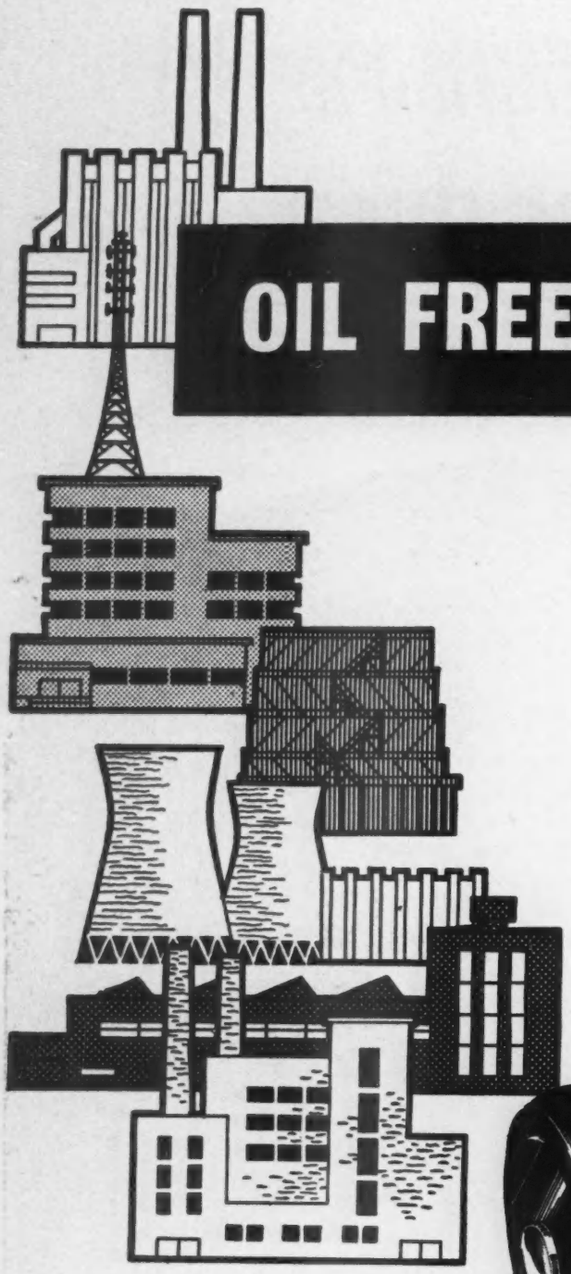

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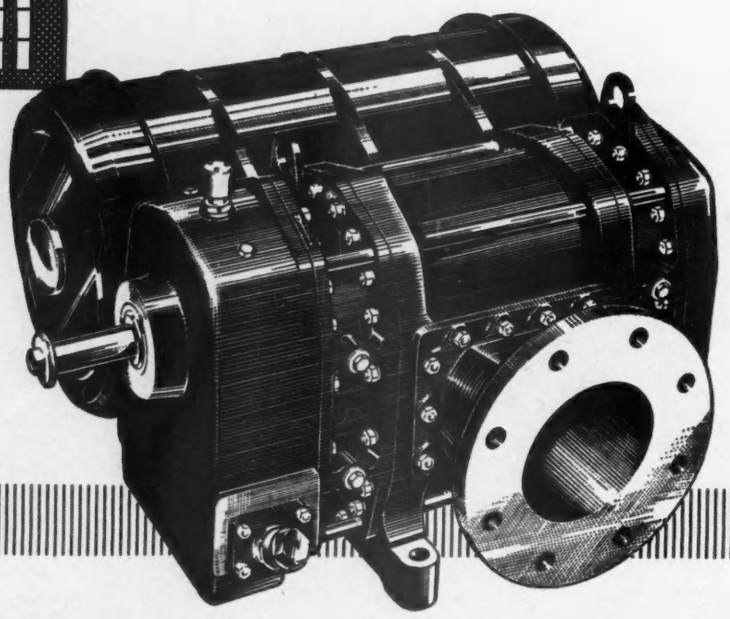

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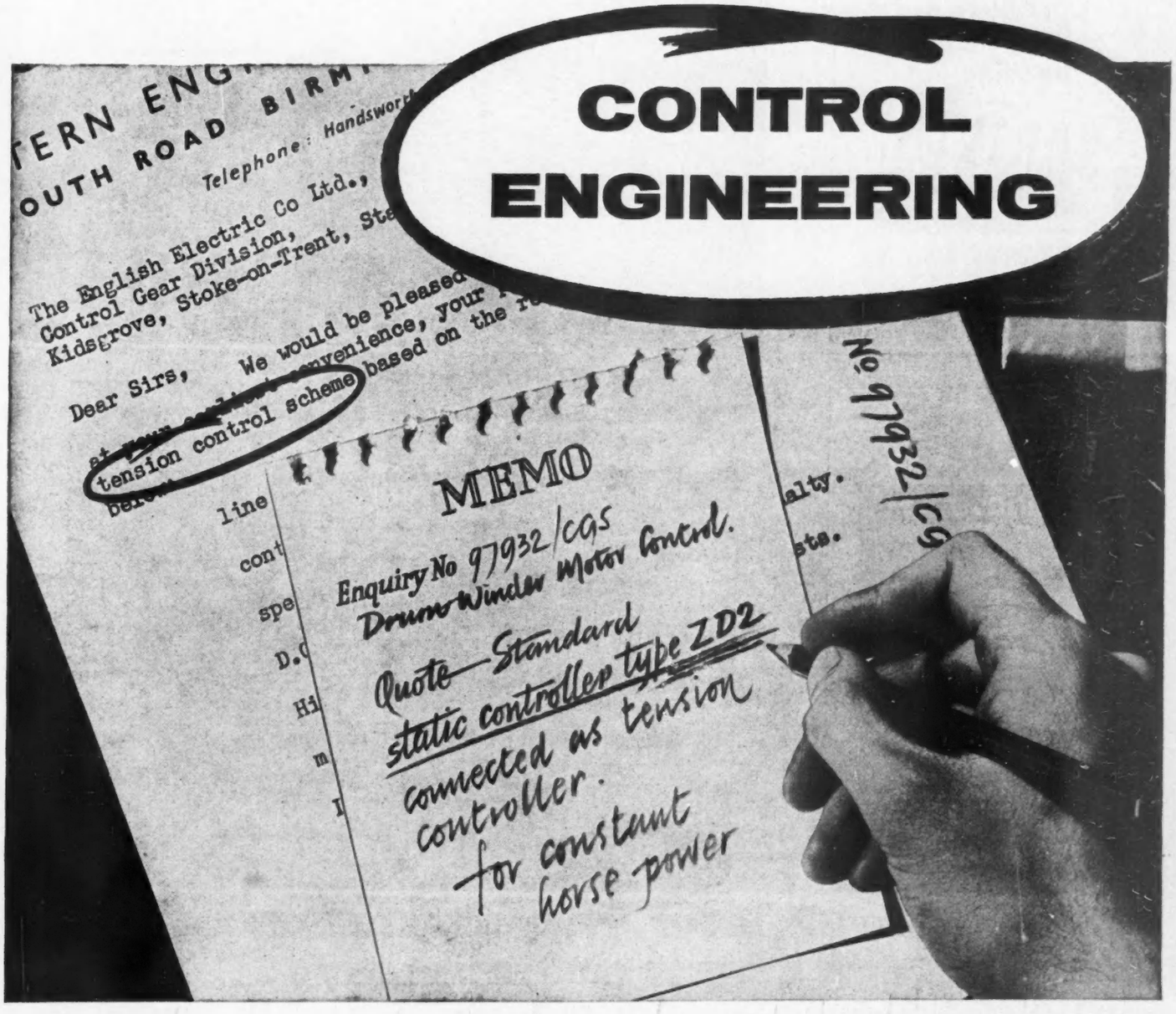

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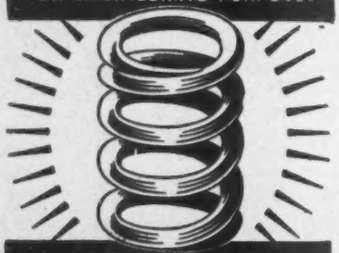

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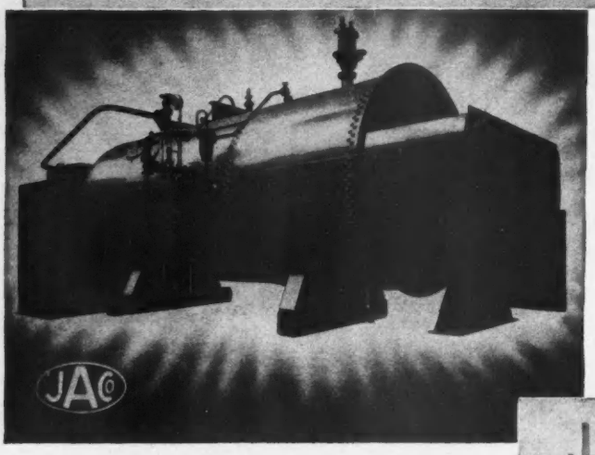

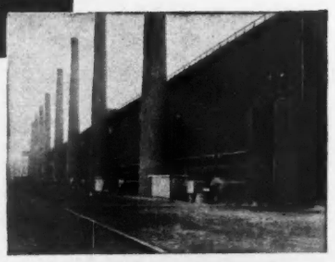

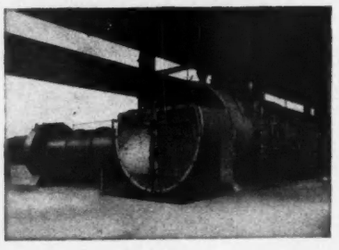

The Joseph Adamson Waste Heat Boiler is designed to make efficient use of the waste gases leaving open-hearth furnaces, reheating furnaces, soaking pits, gas retorts, etc.

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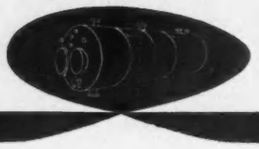
A feature of Joseph Adamson Waste Heat Boilers is that a special cleaning device can be provided in the outlet chamber to allow the tubes to be cleaned while the boiler is at work.



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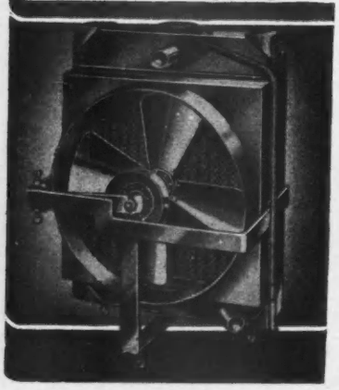

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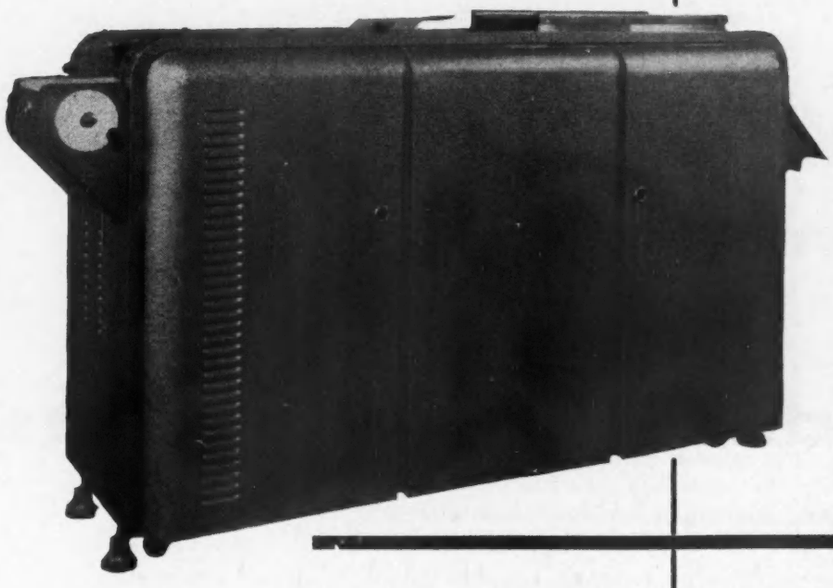

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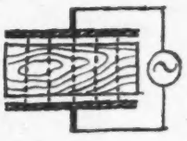
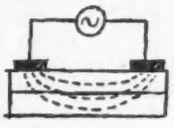
Electrical Aids in Industry *Data Sheet* **No. 10**

Dielectric Heating - 1

When an electrically non-conducting material is placed between two metal plates, called electrodes, connected to an A.C. supply, the alternating electrostatic field between the electrodes considerably speeds up the molecular movements in the material (termed a 'dielectric') as a result of which the temperature of the material under treatment rises. A similar effect is produced where the two electrodes are positioned on the same side of the dielectric; in this case the electrostatic field between them is generally known as a 'stray' or 'fringe' field. For industrial application, the applied voltage of the order of 15,000 volts supplied by an electronic generator alternates at frequencies of some millions of cycles per second.





The amount of heat generated in the dielectric is determined by the frequency, the square of the applied voltage, the dimensions of the object and a physical property of the material termed 'loss factor' and is represented by the equation :—

$$\text{Power} = 1.41\ E^2\ f.\ F\ \frac{A}{t} \times 10^{-12} \text{ kilowatts.}$$

Where E = applied voltage, f = frequency, F = loss factor.

A = area of the dielectric in square inches.

t = thickness of the dielectric in inches.

F, the loss factor, is itself equal to the expression K Cos Ø in which:

K = the dielectric constant, a measure of the property of the material to retain energy arising from disturbance of its molecular structure.

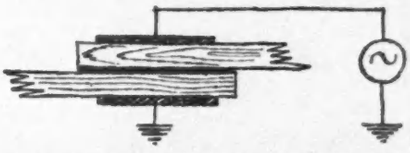
Cos Ø = the dielectric power factor of the material, i.e. the ratio of the power (in watts) to the product (in volt-amperes) of the voltage and current. This is a characteristic property of the material.

Therefore, 'loss factor' is a property of the material and a measure of the ease with which it can be heated by this method. Like other physical properties, it varies considerably for different substances. The equation shows that the heat generated in a dielectric is proportional to its loss factor, but the rate of rise of temperature will also depend upon its specific heat and density. The following table gives approximate values of the dielectric constant, power factor and loss factor of a few typical dielectric materials for frequencies around a million cycles a second.

MATERIAL	DIELECTRIC CONSTANT	POWER FACTOR	LOSS FACTOR
Natural Rubber	2·9	0·02	0·058
Oak, dry	3·3	0·04	0·132
P.V.C.	5·3	0·06	0·318
Urea formaldehyde	7·0	0·03	0·21
'Bakelite' resin	6·0	0·03	0·18
Nylon	3·7	0·05	0·185
Water, pure	80·0	0·03	2·40
Water, tap	80·0	0·5/5·0	40/400

The high loss factor of water means that materials which are difficult to heat when completely dry will often heat efficiently when moisture is present. The voltage must be increased towards the end of the process in some cases to remove the final moisture traces, the reduction in loss factor as the material dries out providing a safeguard against overheating.

Dielectric heating of a homogeneous material is a straightforward application, heat being generated uniformly throughout. If the workpiece is made up of a number of materials, each material will heat up uniformly but each at a rate depending upon its loss factor, thermal properties and density. The degree of temperature uniformity throughout the workpiece will then depend upon the extent to which thermal conductivity can equalise different rates of heating.



Such different rates of heating can be turned to good account in certain applications. For example, in wood glue setting, the glue lines heat up much more rapidly than the wood pieces being joined and the glue sets before the wood heats up substantially, wood having a lower loss factor than glue. Dielectric heating does not depend upon any external heat source to transfer heat by conduction, convection or radiation to the surface of the charge and from thence to the interior by conduction.

Instead, heat is generated within every particle of a body placed in the dielectric field and, depending upon the uniformity of such a body, an even and extremely fast temperature rise can be achieved.

For further information get in touch with your Electricity Board or write direct to the Electrical Development Association, 2 Savoy Hill, London, W.C.2. Telephone: TEMple Bar 9434.

Excellent reference books on electricity and productivity (8/6 each, or 9/- post free) are available — "Induction and Dielectric Heating" is an example.

E.D.A. also have available on free loan in the United Kingdom a series of films on the industrial uses of electricity. Ask for a catalogue.

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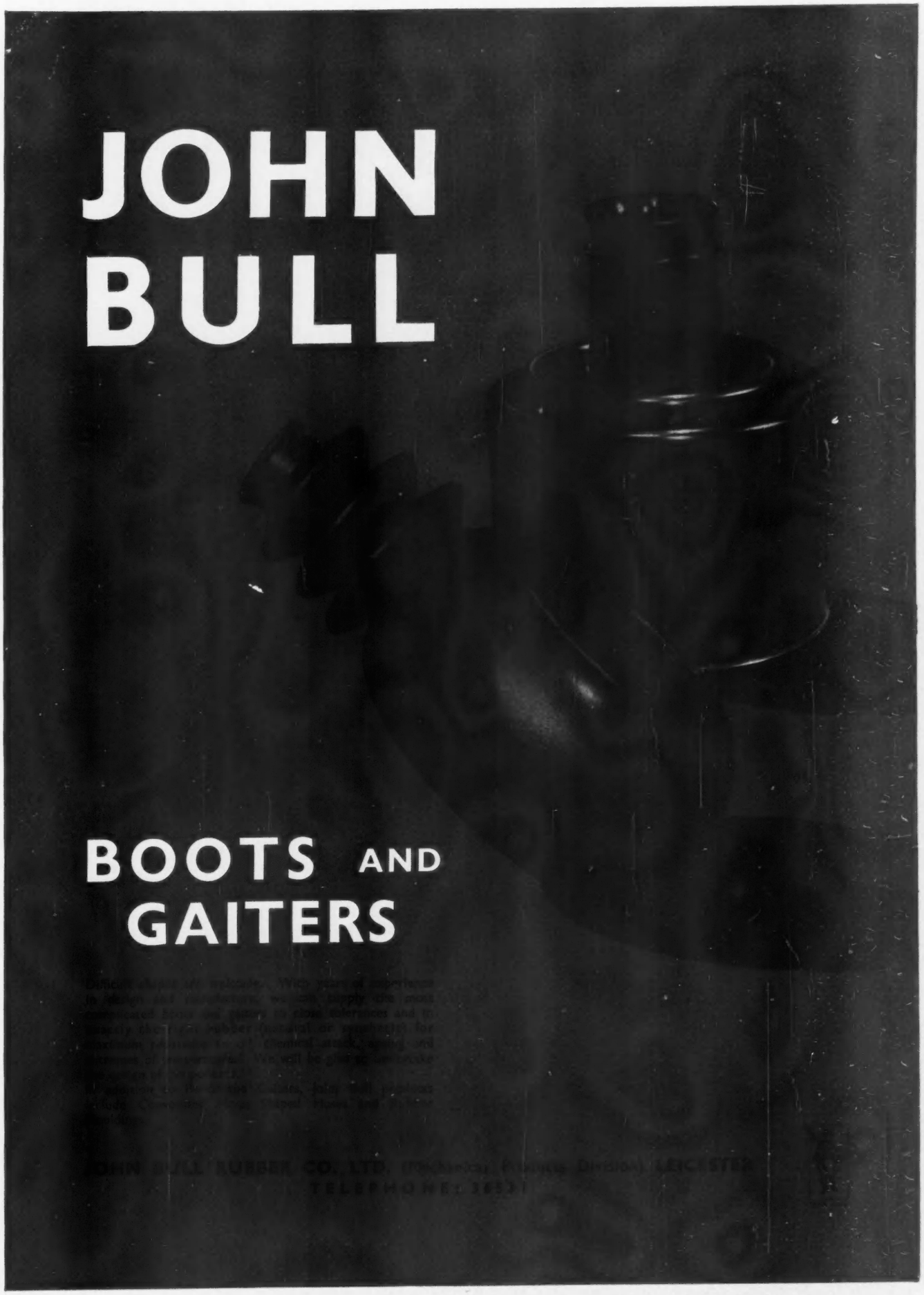
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